

# REPORT ON THE PARASITIC NEMATODES IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA.

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## INTRODUCTION.

The following report deals with an extensive collection of nematodes kindly submitted to us for determination by Dr. N. Annandale, Director of the Zoological Survey of India. It comprises material belonging to the Indian Museum, Calcutta, and material, collected since August, 1916, belonging to the Zoological Survey. A



large proportion of this material was collected from animals, mostly Indian, in the Zoological Garden, Calcutta. This applies to the majority of the species for which no locality is given.

It is difficult to judge to what extent the range of hosts of a parasite may be affected by the presence of a number of suitable hosts in more or less close proximity under artificial conditions in a menagerie. It has been observed that wild animals tend to lose their original parasitic infections after a short time in captivity; but there are some indications in the present collection that a parasite hitherto only known to occur in one or two hosts may, under these conditions, have been enabled to extend its range to hosts with which it would not normally have come into contact. As instances we may mention particularly the cases of *Ascaris lumbricoides* and the various species of *Heterakis*, especially *H. longicaudata*; while it seems probable that the species of *Ancylostoma*, *Belascaris* and *Toxascaris* enjoy exceptional opportunities in this respect in a menagerie where many kinds of carnivores are kept near to each other. The lists of hosts that we have been able to compile for these forms seem to bear out this suggestion.

As regards the position of parasites in their hosts, there was a certain amount of vagueness in many of the original labels. Often the label indicated the "intestines," but this term appears to have been applied somewhat widely to include most of the abdominal and thoracic viscera, and on this account we have decided, in many cases, to omit any mention of the site of election. The species of *Heterakis* from birds, for example, are usually found in the caeca of their hosts, and to mention the "intestines" conveys no information of any value.

The present report deals mainly with nematodes from vertebrate hosts, although two forms found in invertebrates are described. The material submitted to us also included a number of Mermithidae, but we have not attempted as yet to deal with these, and have thought it advisable to publish without unnecessary delay the results of our work on the more strictly parasitic forms. These include members of nearly every superfamily, and, while the number of new species is not large, the collection is valuable for the light it throws on a number of imperfectly known forms, and for the general idea it furnishes of the parasitic nematode fauna of India.

Throughout the report the names used for the hosts, so far as Indian animals are concerned, are for the most part those given in the *Fauna of British India* (Mammalia, by W. T. Blanford, 1888—1891; Birds, Vols. I—II, by E. W. Oates, 1889—1890, and Vols. III—IV, by W. T. Blanford, 1895—1898; Reptilia and Batrachia, by G. A. Boulenger, 1890; Fishes, by F. Day, 1889). The names of hosts (other than domestic animals) which are not indigenous in the Indian Empire are marked with an asterisk (\*).

Superfamily ASCAROIDEA, Railliet and Henry, 1915.

Family ASCARIDAE, Cobbold, 1864.

Subfamily ASCARINAE, Travassos, 1913. (Askarinae Raill. and Henry, 1912.)

Genus *Ascaris*, L., 1758.

*Ascaris lumbricoides*, L., 1758.

The collection contains material which we refer to this species from an interesting range of hosts :—

Man (European boy, Calcutta).

Orang Utan \* (*Simia satyrus*).

Large Indian squirrel (*Sciurus indicus*).<sup>1</sup>

Irrawaddy squirrel (*Sciurus pygerythrus*).<sup>2</sup>

“Squirrel.”

This species is, of course, known to be a parasite of the larger apes, as well as of man. It has long been a matter of opinion whether the form, often called *A. suum* or *A. suilla*, occurring in pigs, both domesticated and wild, is or is not a distinct species from *A. lumbricoides*. The discovery of what appear to be full-sized specimens of the human worm in squirrels is of great interest, especially when the relatively small size of these animals is taken into account. We have carefully examined and compared specimens from man, from an Indian wild pig, and from the above-mentioned squirrels, paying particular attention to the characters of the lips, of the male tail, and of the eggs, and our view is that all belong to the same species. The number and arrangement of the caudal papillae of the male have been well figured by Schneider (1866, p. 37). Quite characteristic is the presence of two pairs of large double papillae behind the cloaca, and three small simple papillae, arranged in a triangle, on either side posteriorly. There is also constantly a pair of double papillae at some little distance from the cloaca, in the preanal series, though the corresponding papillae of the two rows are usually very asymmetrical in position. A curious, large, median, papilla-like structure, or cushion, just in front of the cloaca, and the short, broad, dorso-ventrally flattened, non-alate spicules, somewhat enlarged in the distal half, are also characters common to all the material.

As regards the lips, little need be said except that no accurate account of the cephalic papillae appears to exist. The dorsal lip carries two large, lozenge-shaped papillae, with double terminations, near its lateral margins, while each ventro-lateral lip has (a) towards the ventral side a large, double papilla, and (b) towards the opposite side *two small, separate, simple papillae*. In the presence of these papillae, and in all other respects, the lips of individuals from man, pig and squirrel seem to us to agree.

The supposed differences between *A. lumbricoides* and “*A. suilla*” are based chiefly on size, the worms found in the pig being usually of slenderer build than those from man. E. Blanchard (1849)

<sup>1</sup> Now known as *Ratufa indica*. See Robinson and Kloss, *Rec. Ind. Mus.* XV, p. 186 (1918).

<sup>2</sup> Now known as *Tomeutes pygerythrus*; *loc. cit.*, p. 226.



also mentions differences in the relative lengths of parts of the female reproductive organs, but such differences may constantly be observed in female nematodes of different ages, of the same species and from the same host. In our opinion, the evidences of identity furnished by the structural characters mentioned are of much greater weight.

Recent experimental work by Stewart and others has shown that *A. lumbricoides* can reach a certain stage of development in the rat, mouse, guinea-pig and rabbit, but it has not yet been found to settle in the intestine and attain sexual maturity in these animals. The present record of the adult worm in squirrels (assuming, as we believe to be justifiable, that the species is the same), shows that the development may, under suitable conditions, be completed in a rodent.

### *Ascaris vitulorum*, Goeze, 1782.

(Figs. 1—3.)

The distinctive characters of this form do not seem to be at all well known, and we are not aware of any recent description of it.<sup>1</sup> Ransom (1911) gives only the briefest details of its anatomy, and these seem to have been mainly quoted from Neumann. A few specimens taken from a calf at Siripur, Bihar, though in rather poor condition, enable us to add a few details to the description, and to correct others.

Our specimens measure from 85 mm. (male) up to 140 mm. (female) in length. The cuticle is marked with transverse rings at intervals of 0.03–0.075 mm. Finer striations, if present, were not seen.

The diameter of the head, at the base of the lips, is about 0.5 mm.; that of the neck, immediately behind the lips, 0.7 mm. The lips (fig. 1) are broad at the base and narrow in front. The dorsal lip carries a pair of large, simple papillae; each ventro-lateral lip a large, lozenge-shaped papilla towards the ventral side and a small, round papilla laterally and more anteriorly. The pulp of each lip sends out two rounded lobes anteriorly, and from the inner surface of each lobe a blunt, inwardly-directed process originates. The two processes converge slightly towards the middle line of the lip. Dentigerous ridges, with coarse teeth,

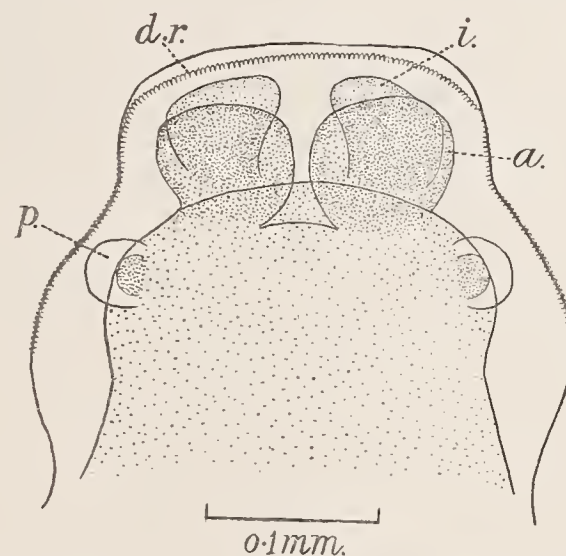


FIG. 1.—*Ascaris vitulorum*. Dorsal lip, viewed from exterior.

*a.*, anterior lobe of pulp; *d.r.*, dentigerous ridge; *i.*, internal process of anterior lobe; *p.*, papilla.

are present. There are no interlabia. The oesophagus is modified posteriorly into a small, almost globular "ventriculus," or glandular bulb (fig. 2), measuring about 0.35 mm. long and 0.45 mm. wide. This is not distinctly constricted off from the muscular portion of the oesophagus, but is preceded by a slight narrowing of the latter. The entire oesophagus measures about 4 mm. in length. The nerve-ring surrounds it at about 0.8 mm. from the anterior extremity.

<sup>1</sup> Since this paper was prepared, a description has been published by Boulenger (*Parasitology* XIV, 1, 1922, p. 87), which agrees on the whole with ours, except that he appears to have seen more pairs of postanal papillae than we could detect in our material.



The tail of the male (fig. 3) measures 0.33 mm. in length. It is not, as is sometimes stated in text-books, without postanal papillae. On the contrary, it possesses three

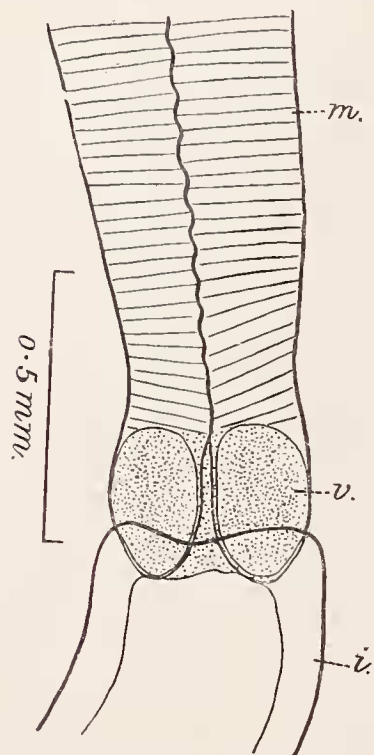


FIG. 2.—*Ascaris vitulorum*. Posterior portion of oesophagus and commencement of intestine.

i., intestine; m., muscular portion of oesophagus; v., ventriculus.

pairs on the ventral surface, of which the most anterior consists of very large, double papillae. There appear to be about nine pairs of preanal papillae. The spicules are stout, tubular and without alae. They were unfortunately broken in our specimens, and we are unable to give their length. Their diameter is about 0.043 mm.

The vulva is situated at about 17 mm. from the anterior end in a specimen mm. 125 long, thus dividing the body in the proportion of about 1:6. The vagina and the unpaired portion of the uterus run back, gradually widening, with a rather sinuous course, to a point about 11 mm. behind the vulva, before giving off the two parallel uterine branches. The coils of the ovarian tubes return towards the anterior end as far as the level of the vulva. The eggs are oval, and have a thick, coarsely granulated shell and an unsegmented content. They measure 0.075–0.09 × 0.06–0.07 mm.

#### *Ascaris*, sp.

A small immature female, from the intestine of a wild pig (*Sus bengalensis*), near Dinapore, Bihar. It is doubtful whether this can be assigned to *A. lumbricoides*.

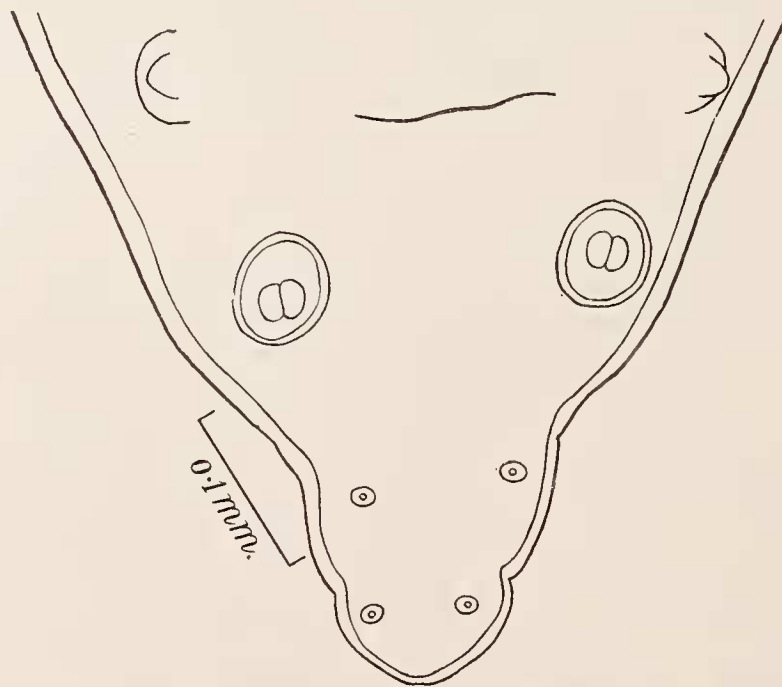


FIG. 3.—*Ascaris vitulorum*. Tail of male; ventral view.

**Ascaris**, sp. (?)

A single immature specimen, about 14 mm. in length, from *Varanus salvator*. We are unable to assign this definitely to any species.

Genus **Belascaris**, Leiper, 1907.

**Belascaris mystax** (Zeder, 1800).

This species occurs in the collection from the following hosts:—

Domestic cat.

Siamese domestic cat.

Tiger (*Felis tigris*).

Leopard (*Felis pardus*).

Jungle cat (*Felis chaus*).

Leopard cat (*Felis bengalensis*).

Fishing cat (*Felis viverrina*).

**Belascaris marginata** (Rud., 1802).

In addition to a single female of this species from a jackal and some doubtful specimens, in very poor condition, from an Indian wolf (*Canis pallipes*), the collection contains a number of Ascarids from the stomach and intestine of an Indian fox (*Vulpes bengalensis*). After comparison with material from the domesticated dog, we conclude that these worms from the fox belong to the same species (*B. marginata*). It may be mentioned in this connection that Riley (1921) states that this species frequently occurs in foxes farmed for commercial purposes in Canada and the United States. At the same time, the *Ascaris vulpis* of Frölich, 1789 (= *A. triquetra*, Schrank, 1790), was regarded by Railliet and Henry (1911) as a distinct species of *Belascaris*, although no satisfactory description of it appears to exist. The only distinctive features of this supposed species mentioned by Railliet and Henry are the greater development of the caudal alae, and the presence of a gutter-like depression of the ventral surface of the tail, in the male. These, as it seems to us, are appearances which might easily be the result of imperfect preservation or extreme contraction, and there appears to be no other ground for accepting *Belascaris vulpis* as a valid species.

It is appropriate in this place to refer to two other species recorded from more or less closely related hosts. *Belascaris masculior*, Railliet and Henry, 1911, from the Fennec fox (*Megalotis zerda*), appears to be a species of smaller average dimensions than *B. marginata*, but with somewhat longer spicules. There is nothing else in the description by which it can be differentiated.

*B. melis*, Gedoelst, 1920, from the badger, attains a very large size, though its spicules are not longer than those of *B. marginata*. According to Gedoelst's account, there are only three pairs of papillae on the terminal appendage of the tail in the male, instead of the five pairs usual in the genus, and the number of preanal papillae appears to be unusually large.

Genus **Toxascaris**, Leiper, 1907.

**Toxascaris leonina** (v. Linst., 1902).

This species occurred in the following hosts :—

Lion (*Felis leo*).

Tiger (*Felis tigris*).

Leopard (*Felis pardus*).

Ounce, or Snow leopard (*Felis uncia*).

Fishing cat (*Felis viverrina*).

Leopard cat (*Felis bengalensis*).

Hunting leopard (*Cynaelurus jubatus*).

(?) Indian fox (*Vulpes bengalensis*).<sup>1</sup>

**Toxascaris transfuga** (Rud., 1819).

(Figs. 4, 5.)

The collection contains abundant Ascarid material from bears—the Himalayan black bear (*Ursus torquatus*) and the sloth-bear (*Melursus ursinus*)—and also from the red cat-bear (*Aelurus fulgens*), all of which we refer to *Ascaris transfuga* Rud. *Aelurus* appears to be a new host for this species. Examination of the material shows clearly that *A. transfuga* has all the essential characters of the genus *Toxascaris*, as defined by Leiper (1907) and by Railliet and Henry (1911).

The best description of the species at present existing appears to be that of Dujardin (1845), but he gives no figures. Schneider ((1866), pl. I, fig. 3) gives an accurate figure of the dorsal lip, seen from the inner surface, but we are unable to find a figure of the tail of the male. The characters of this, and of the dorsal lip as seen from the outer surface being of considerable importance, we have prepared figures to illustrate these points, and we propose to amplify the description somewhat.

The size attained sometimes exceeds the measurements given by Dujardin. We have examined one female specimen (not in the present collection), from the brown bear, which measured as much as 240 mm. in length and about 4.5 mm. in thickness. This, however, appears to be exceptional. The anterior end of the worm (in spirit) is usually, though not invariably, curved towards the dorsal side. The lips are roughly semicircular in outline, and each carries two papillae, those of the dorsal lip (fig. 4) being equal and symmetrically arranged, while those of each ventro-lateral lip are rather unequal and asymmetrical, the papilla towards the ventral side being large, the more lateral papilla smaller and situated slightly further forward. The pulp of each lip sends out five processes, two in a transverse direction, near the ends of which are the papillae, and three anteriorly. Of the anterior processes two form large paired lobes which expand slightly and have a shallow longitudinal groove on their inner surfaces at their distal ends (*cf.* Schneider's figure). The third is the

<sup>1</sup> The last record may perhaps be due to a clerical error in the collector's label, *Vulpes* having been written by a *lapsus* for *Felis*.



median unpaired lobe, which is a supporting structure for the cuticle of the inner surface of the lip, and appears to end in short rays which spread out beneath the cuticle. The paired anterior lobes originate from the inner side of the main pulp of the lip somewhat behind its anterior limit, so that a kind of transverse groove, as described by Railliet and Henry for the type-species, is formed between the main mass and the anterior lobes. Marginal dentigerous ridges, composed of relatively very large and rather irregular teeth, are present.

The cervical alae are well-developed. The oesophagus is simple (without ventriculus) and club-shaped, very stout posteriorly (up to 0.95 mm.), and measures 4-5 mm. in length. There are no oesophageal or intestinal diverticula.

The caudal end of the male (fig. 5) is curved ventrally, but the extremity is usually recurved towards the dorsal side. The tail itself measures 0.45-0.5 mm. in length, is bluntly conical, and ends in a short spike which has a small terminal button, and thus resembles a terminal papilla. The postanal papillae correspond in number, though not exactly in position, with those of *T. leonina*, the genotype. There are (1) a group of four pairs near the tip of the tail, consisting of two very small ventral and two larger, more lateral pairs. Of the latter the more posterior is the most laterally situated, and the more anterior is the largest, of the group; (2) an isolated, quite lateral pair; (3) a large pair with double terminations, situated at the posterior limit of a kind of raised wall of cuticle which runs forward and round the cloaca, bounding a horseshoe-shaped depression. The edges of this "wall" are usually curved inwards, so that the terminations of the papillae face towards the mid-ventral line; (4) the first of a series of upwards of thirty pairs of papillae which extend for a considerable distance in front of the cloaca. These papillae are at first close together, and each row tends to resolve itself into two alternating rows, but further forward the row becomes simple and the papillae wider apart. The spicules are very short (about 0.65 mm.) and stout, and are tubular structures without alae, and covered with small granulations.

The tail of the female is short and bluntly conical, almost rounded posteriorly, but with a small papilla-like termination, as in the male. The vulva is situated at about the anterior third of the total length in young females, but in large examples the post-vulvar portion of the body appears to have grown more rapidly than the anterior part, so that the vulva divides the body in the proportion, roughly, of 2:5. The

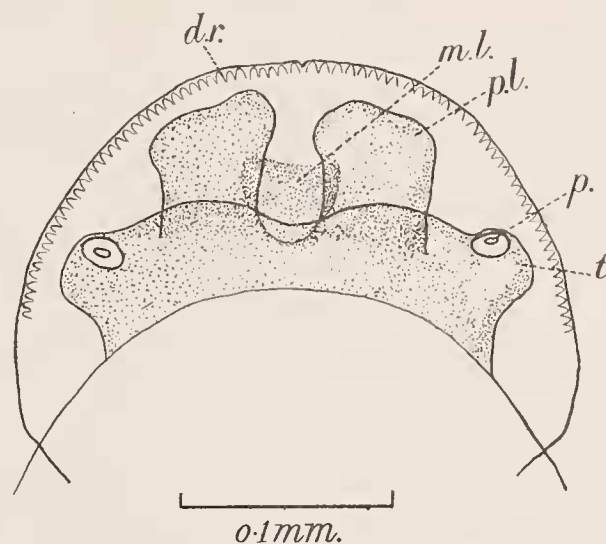


FIG. 4.—*Toxascaris transfuga*. Dorsal lip, viewed from exterior.

*d.r.*, dentigerous ridge; *m.l.*, median lobe of pulp; *p.l.*, paired anterior lobe; *p.*, papilla; *t.*, transverse process of pulp.

narrow, convoluted vagina opens into a short (not exceeding 5 mm.) unpaired uterine chamber, as described by Dujardin, from which the two branches of the uterus run

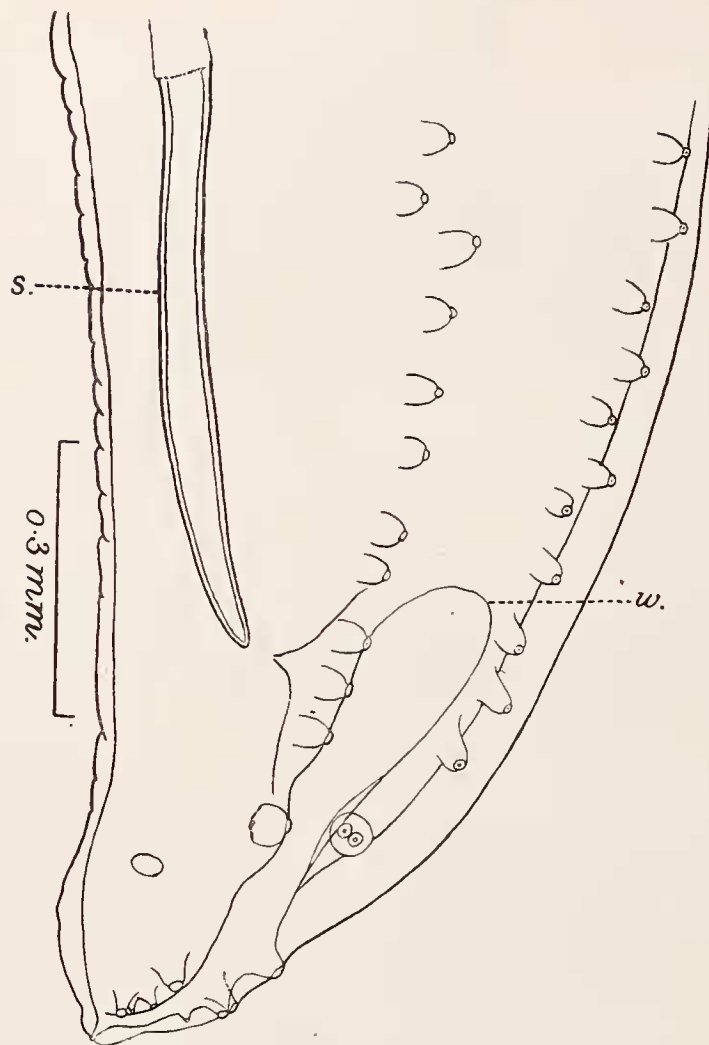


FIG. 5.—*Toxascaris transfuga*. Tail of male; latero-ventral view.

s., right spicule; w., wall of depression surrounding cloaca.

back parallel to each other, and nearly straight in large specimens. The coils of the ovarian tubes, after running nearly to the posterior end of the body, return anteriorly as far as the level of the vulva. The eggs are oval (not globular), and have a thick, smooth shell measuring  $0.0775-0.09 \times 0.06-0.075$  mm. When ready for laying, this shell appears to become covered, as in *Ascaris lumbricoides*, with an irregular external coat of a yellowish albuminoid substance, which perhaps gave Dujardin the impression of a "punctulated" shell. The content of the egg is unsegmented at the time of laying.

Genus *Ophidascaris*, Baylis, 1921.

*Ophidascaris filaria* (Duj., 1845).

This species occurred in abundance in the alimentary canal of *Python molurus* on nineteen occasions. We have also to record the presence of immature forms of various ages in the lung of *Python molurus* and *P. reticulatus*. In two cases the same animal

harboured adults in the intestine and larvae in the lung at the same time. The immature worms in the lung measured from about 9 to 60 mm. in length, but in the largest of them the lips had not yet acquired their definitive structure (except in one case where the label stated that the material came from the lung, but the accuracy of this statement may be doubted, as the uteri of the females already contained ova).

From the occurrence of the young forms in the lung of the python, it appears probable that the larvae have a course of migration within the body of the host, like that of the larvae of *Ascaris lumbricoides*, before finally establishing themselves in the alimentary canal.<sup>1</sup>

<sup>1</sup> It has recently been shown by Ortlepp (*Jl. of Trop. Med. and Hyg.*, XXV, p. 97) that the embryos of *Polydelphis attenuata* are capable of partial development in the mouse, and that they migrate through the lungs as in the case of *Ascaris lumbricoides*. Our note was written before the appearance of Ortlepp's paper.

**Ophidascaris naiae** (Gedoelst, 1916).

We refer tentatively to this species forms found in the intestine of a cobra (*Naja tripudians*) and in the stomach and intestine of two kraits (*Bungarus fasciatus*). Their determination is open to question, all being young and not yet full-sized, although two of the females contain ova. Apart from measurements, they seem to agree fairly well with Gedoelst's (1916) rather brief description.

Genus **Polydelphis**, Duj., 1845.

**Polydelphis sewelli**, sp. nov.

(Figs. 6, 7.)

Host: Montpellier snake (*Coelopeltis monspessulana*\*). Locality: Khan-Yunis, Palestine, May, 1917.

Some Ascarids collected from the "abdomen and lung" of the above-named snake by Major R. B. S. Sewell prove to belong to the genus *Polydelphis*, and to the section of that genus in which the uterus has six branches.<sup>1</sup> The worms are relatively slender and of almost uniform thickness throughout. The male measures about 66 mm. in length and 1.2 mm. in thickness, the female 73 mm. and 1.4 mm. respectively. The cuticular striations are exceedingly fine. The diameter of the head is 0.3–0.34 mm. The lips (fig. 6) are somewhat hexagonal in outline, and slightly broader than long. Their anterior and lateral borders are somewhat emarginate. Marginal dentigerous ridges are present, and the pulp of the lip has two well-developed antler-like anterior lobes, each having two main divisions. The dorsal lip carries two simple lateral papillae, each ventro-lateral lip one large ventral and one very small lateral papilla. The oesophagus is simple, somewhat enlarged posteriorly, and measures about 5 mm. in length. There is, at least in some individuals, an intestinal caecum, which may reach a length of about 0.6 mm., or may be quite rudimentary and not more than 0.125 mm. long. A pair of very small cervical papillae is present at about 1.4 mm. from the anterior end. The nerve-ring is situated at 0.7–0.85 mm. from the same point.

The tail, in both sexes, is very short and rounded, and terminates in a small spike about 0.05 mm. long.

In the male, the tail (fig. 7) measures 0.25 mm. in length. The spicules are short, subequal and broadly alate. The right spicule measures 1.35 mm., the left 1.4 mm., and the dorso-ventral diameter of each is about 0.06 mm. The preanal

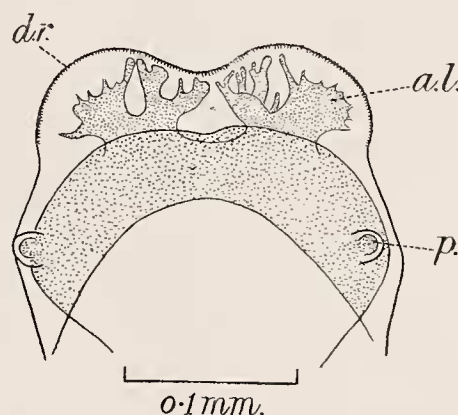


FIG. 6.—*Polydelphis sewelli*. Dorsal lip of female, viewed from exterior.

a.l., anterior lobe of pulp; d.r., dentigerous ridge; p., papilla.

<sup>1</sup> See Baylis (1921).



papillae are arranged in a single fairly regular and close series of about 43 on either side. There is also one papilla, more laterally situated, at about the same level as the fourth of the series, on each side. There are six pairs of postanal papillae, of which the first, or most posterior, papilla on each side is relatively large and dorsally placed; the second is very small and lateral; the third, fourth and fifth form a triangle, two of them being ventral and one more lateral; and the sixth is a large, double papilla near the cloaca and separated by a considerable space from the rest.

The tail of the female is 0.3 mm. long. The vulva is situated at about 34 mm. from the posterior end, dividing the body in the proportion of about 19 : 17. The

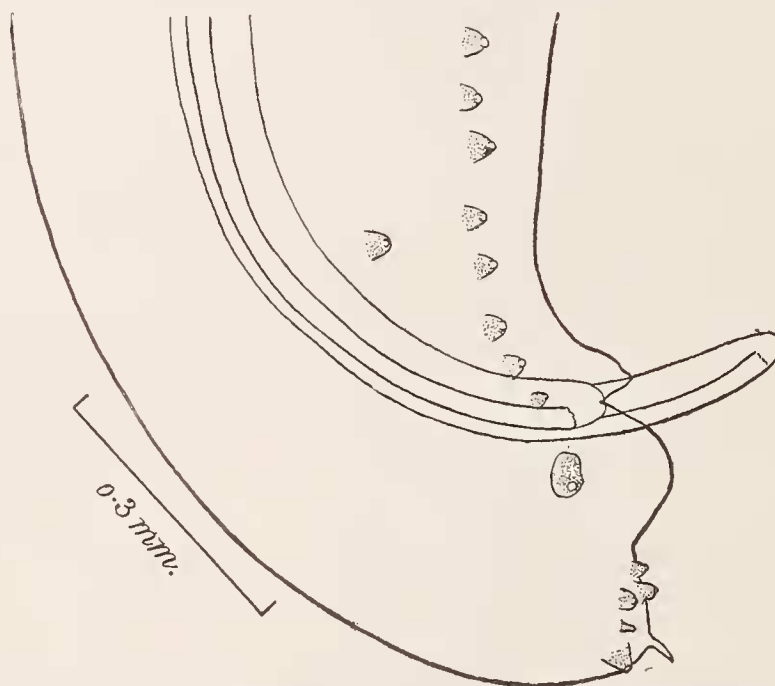


FIG. 7.—*Polydelphis sewelli*. Tail of male; lateral view.

narrow, irregularly coiled, muscular vagina leads into a common uterine chamber about 1.6 mm. long, which gives off the six parallel uterine branches posteriorly. These run back to a point about 15 mm. from the posterior end, where they pass into the ovarian tubes. The coils of the latter extend back to 10 mm. from the posterior end, and then run forward to the level of the vulva. The ova are roundish-oval or nearly spherical, and have a thick, finely granulated shell, measuring 0.09–0.1 × 0.075–0.087 mm.

***Polydelphis oculata*** (v. Linst., 1899) (?).

Two females from the stomach of a python from Assam (? *Python molurus* or *P. reticulatus*) may belong to this species, but are in too poor a condition to be determined with certainty.

***Polydelphis*, sp.**

[near to *P. hexametra* (Geddoelst, 1916).]

Two female specimens, one in very poor condition, were taken on separate occasions from examples of the common chameleon of India (*Chamaeleon calcaratus*). They belong to the section of the genus in which the number of uterine branches is

six, but it is impossible to determine whether the species is identical with the *Ascaris hexametra* of Gedoelst (1916), from an African chameleon.

Subfamily *ANISAKINÆ*, Railliet and Henry, 1912, *emend.* Baylis, 1920.

Genus *Porrocaecum*, Railliet and Henry, 1912.

*Porrocaecum crassum* (Deslongchamps, 1824).

One female specimen of this species was collected from a duck, at Bombay.

*Porrocaecum depressum* (Zeder, 1800).

(Fig. 8.)

Examples of this species occurred in the intestine of the cinereous vulture (*Vultur monachus*). The characters of the dorsal lip and of the male tail have been figured by Schneider (1866). We append a new figure of the dorsal lip for purposes of comparison with the next species, *P. angusticolle*, since the differences between these two species are so slight as to require emphasis.

*Porrocaecum angusticolle* (Molin, 1860).

(Figs. 9, 10.)

The material consists of a few complete specimens and some fragments from a kite (*Milvus govinda*).

This species is nearly related to the foregoing. The female was well described by von Drasche (1883), who figured the dorsal lip. The male has, up to the present, not been described. The principal character

which serves to distinguish the species from *P. depressum* is the shape of the pulp of the dorsal lip. In *P. angusticolle* the dorsal lip is almost hexagonal in outline. The main mass of the pulp resolves itself into two principal lobes, rounded anteriorly and joined by a saddle. Springing from the inner surfaces of these lobes are two processes which become visible anteriorly as two projecting plates, flattened and expanded distally. Towards the base of the lip there is on either side a cuticular band (fig. 9, c.) which stands out somewhat prominently. There is the usual pair of papillae on the dorsal lip, while a dentigerous ridge may be traced round the greater portion of the lip near its edge. Small triangular interlabia are present. Figs. 8 and 9 show the difference between this arrangement and that of *P. depressum*. In the case of the latter each of the main lobes divides anteriorly into two more or less finger-like processes, as described by Schneider, while internally there is a large, median lobe, rounded anteriorly, which is distinctly visible where it projects beyond the saddle joining the two main lobes.

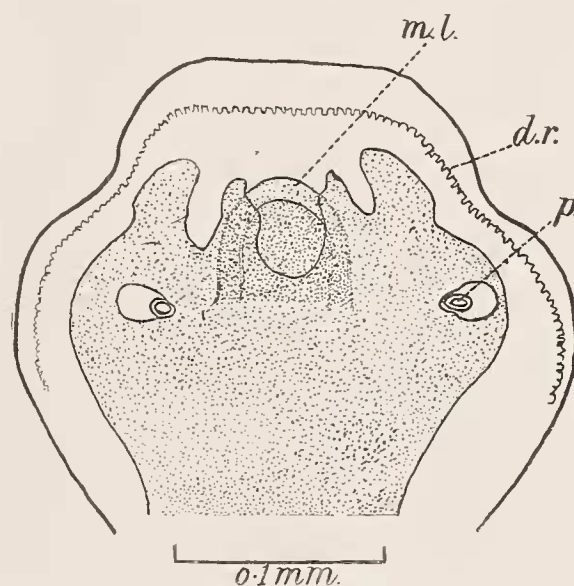


FIG. 8.—*Porrocaecum depressum*. Dorsal lip of female, viewed from exterior.

d.r., dentigerous ridge; m.l., median lobe of pulp; p., papilla.

The male measures up to 55 mm. in length and 1.1 mm. in thickness: the female 90 mm. and 1.5 mm. respectively. The cuticle has transverse striations about 17 $\mu$  apart.

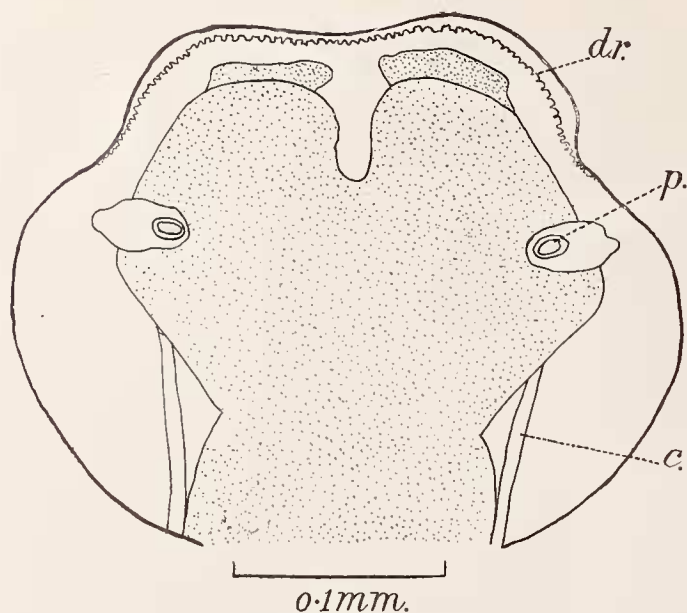


FIG. 9.—*Porrocaecum angusticolle*. Dorsal lip of female, viewed from exterior.

c., "cuticular band"; dr., dentigerous ridge: p., papilla.

Anteriorly the body is tapered for a considerable distance, forming a long, slender neck. The head is small, its diameter being 0.245 to 0.26 mm. There is a slight constriction at the junction of the head and neck. The oesophagus is 4.8 mm. long, including the short, oblong ventriculus, which measures 0.6 mm. in length. The anterior caecal prolongation of the intestine measures from 2.7 to 3.0 mm. in length. The nerve-ring is situated at about 0.85 mm. from the anterior end. At about 1.7 mm. from the head there is a pair of large, sessile cervical papillae. The excretory pore opens, as usual, just behind the base of the lips in the median ventral line.

The tail of the male (fig. 10) is conical and measures 0.39 mm. in length. About half-way between the cloaca and the tip of the tail there is a distinct constriction. There are no caudal alae. The postanal papillae are all sessile. There are about

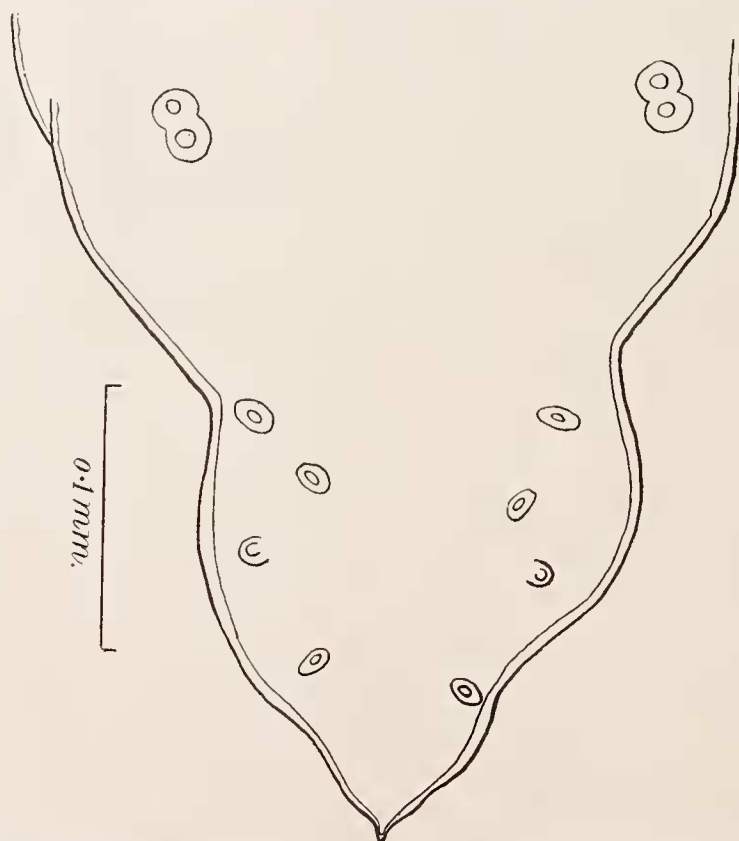


FIG. 10.—*Porrocaecum angusticolle*. Tail of male; ventral view.



twenty pairs of preanal papillae, the most posterior of which is situated just anteriorly to the corners of the cloacal opening. The postanal papillae consist of five pairs; a large, ventral pair of double papillae just behind the cloaca, and the remaining four pairs on the posterior half of the tail, *i.e.*, behind the constriction mentioned above. Two of these latter pairs are distinctly ventral and two ventro-lateral. The spicules are equal and simple (not alate). They measure 0.95 mm. in length.

The tail of the female is blunter than that of the male, and measures 0.7 mm. in length. The caudal papillae are situated at 0.2 mm. from the tip. The vulva is situated in the anterior half of the body, dividing the latter in the proportion of 3 : 5. The eggs measure 0.085–0.093 mm.  $\times$  0.058–0.074 mm.

In addition to the difference in the pulp of the dorsal lip, there are certain other points in which this species diverges from *P. depressum*. The mature female of *P. depressum* is much shorter in proportion to its thickness than the female of *P. angusticollis*, and the vulva in *P. depressum* is situated further back, towards the middle of the body, the proportion in which it divides the body being about 5 : 6.

### ***Porrocaecum serpentulus* (Rud., 1809).**

(Fig. 11.)

Examples of this species occurred in the common crane (*Grus communis*) and in the demoiselle crane (*Anthropoides virgo*). The characters of the head, and more especially of the dorsal lip, have been described and figured by von Linstow ((1899),

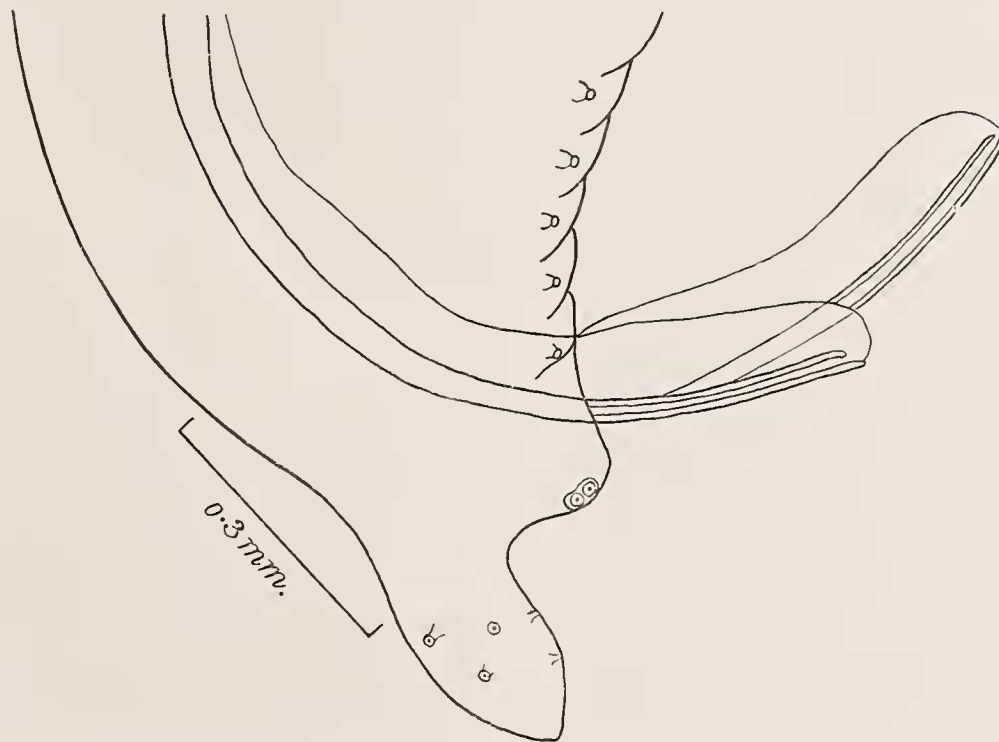


FIG. 11.—*Porrocaecum serpentulus*. Tail of male; lateral view.

p. 7; pl. 1, fig. 9). The bifurcation of the anterior lobes of the pulp of the lip appears to be less pronounced than is indicated in his figure. Dentigerous ridges are not, as he states, absent. In describing the tail of the male the same author

mentions four pairs of papillae on the finger-shaped terminal appendage, two ventral and two "dorsal." We find, in addition to two ventral and two subdorsal pairs, a fifth pair, lateral in position (fig. 11).<sup>1</sup> The one other postanal papilla on either side, mentioned by von Linstow, is on the thicker portion of the body, and is a double papilla, facing posteriorly. There is a regular series of about 15 preanal papillae on either side, as stated by von Linstow. The spicules are equal in length (1.25 mm. in a moderately large specimen). Each is composed of a tubular shaft having a transversely striated appearance and gradually increasing in diameter towards its base, and two very broad membranous alae.

This species, when taken from cranes, has a relatively short and stout build, some females attaining a diameter of about 4 mm. Some specimens from *Ardea cinerea* in the British Museum are so slender in proportion to their length, as compared with those from cranes, that it seemed probable that they belonged to a different species. We have found no important difference, however, in the structure of the head or of the male tail, and therefore conclude that the forms in cranes and in herons are all *P. serpentulus*.

***Porrocaecum reticulatum* (v. Linst., 1899).**

(Fig. 12).

Syn. *Ascaris reticulata*, v. Linstow (1899), p. 7; pl. I, fig. 11.

*Ascaris ardeae*, Smith, Fox and White (1908), p. 287; pl. VI, figs. 1-7.

(nec *Ascaris ardeae*, Frölich, 1802; *A. ardeae*, Diesing, 1851; *A. ardearum*, Rud., 1819.)

Material from the intestines of the Eastern purple heron (*Ardea manillensis*), the night heron (*Nycticorax griseus*) and an egret (species not mentioned), all from the Calcutta Zoological Garden, appears to us to be referable to *Ascaris reticulata*. All our specimens, however, are rather small compared with the measurements given by the authors cited, and although the sexual characters are developed and the females already contain ova, it is probable that they had not yet attained their full size. On comparison of the descriptions and figures given by von Linstow and by the American authors, we feel no doubt as to the identity of *A. reticulata* and *A. ardeae*, Smith, Fox and White. In both cases, however, important points appear to have been overlooked by the observers, as our own material shows. Von Linstow states that interlabia and dentigerous ridges are absent, while omitting any description of the structure of the oesophagus and the anterior part of the intestine. The American authors, on the other hand, observed the well-developed interlabia and the presence of dentigerous ridges, but state that the oesophagus has no "bulb", and make no mention of an intestinal caecum. From our own observations it is clear that the characters of the head have been accurately described by Smith, Fox and White. It is just possible to understand how the interlabia were overlooked by von Linstow, since in a cleared specimen in certain positions they are almost entirely hidden by the lips, and their delicate outlines become very elusive. It is less easy to explain how the American authors failed to see the extremely well-developed intestinal caecum, which runs forward beside the oesophagus for a considerable

<sup>1</sup> Our figure is taken from a specimen from *Grus australasiana*, in the British Museum, and not from Indian Museum material.

portion of its length, and is quite a conspicuous organ. The rather short, oblong ventriculus is less conspicuous, but is not difficult to observe in a well-cleared specimen. All these characters, taken together, leave no doubt as to the generic position of the species.

The characters of the caudal end of the male appear to have been adequately described and figured by Smith, Fox and White, (von Linstow's material consisted of females only)—with the remarkable omission of any mention of an accessory piece, in

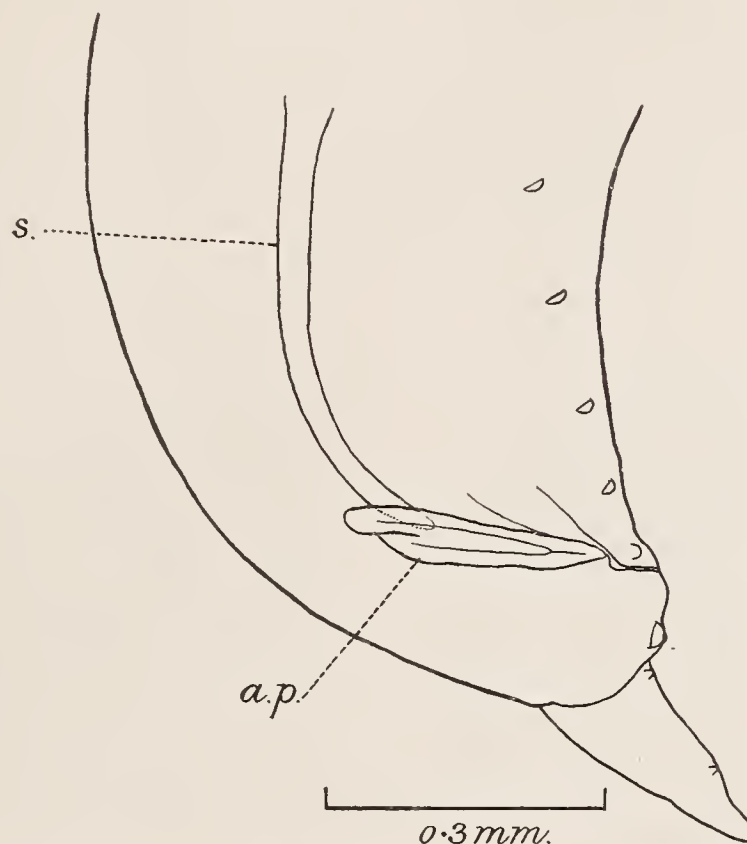


FIG. 12.—*Porrocaecum reticulatum*. Tail of male; lateral view.  
a.p., accessory piece; s., right spicule.

addition to the two spicules. The presence of such a structure in an Ascarid is highly remarkable, yet in the material at our disposal every male possesses a conspicuous accessory piece (fig. 12, a.p.) composed of clear, yellowish-brown chitin. This organ appears smooth, whereas the spicules (which are of a darker colour and are simple, tubular structures, without alae), have a rough, granular appearance. As regards the caudal papillæ of the male, we are in agreement with the description given by the American authors. There are two very small pairs on the finger-like caudal appendage; one large postanal pair just before the constriction of the tail; and an anterior row in which we have counted five on either side, commencing with a pair at the level of the cloaca.

The almost spherical eggs, in our specimens, are slightly smaller than the measurements given by the former describers, but this is possibly due to the immaturity of the females. The egg-shell is pitted externally, as described by the Ameri-



can writers, the walls between the pits doubtless forming the "network of ridges" referred to by von Linstow.

This species is readily distinguished from *P. serpentulus* by the absence of cephalic alae, and by the simple character of the spicules and the presence of an accessory piece in the male.

**Porrocaecum pristis**, sp. nov.

(Figs. 13-15.)

Host: Saw-fish (*Pristis perotteti*). Position: intestine. Locality: Ulubaria, R. Hughli.

The male measures up to 26.6 mm. in length and 0.74 mm. in thickness; the female 34.2 mm. and 1.06 mm. respectively. The diameter of the head is 0.16-0.18 mm. The cuticle has transverse striations 8.7-10 $\mu$  apart. The lips (fig. 13) are small, and pass into the neck without any constriction at their bases. Each has a

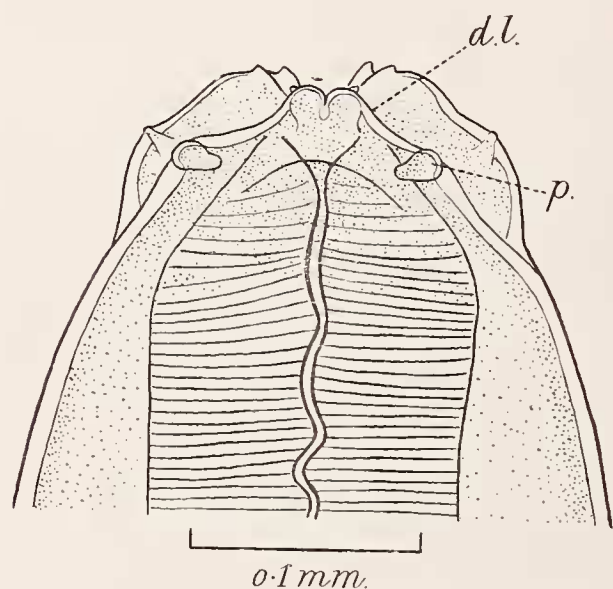


FIG. 13.—*Porrocaecum pristis*. Head of female; dorsal view.

d.l., dorsal lip; p., right papilla of same.

narrow, bilobed, anterior process, carrying two small cuticular projections on its inner surface. The dorsal lip is shorter than the ventro-lateral lips, and has two large papillae. Each ventro-lateral lip has one large, lozenge-shaped ventral papilla and a much smaller lateral papilla, situated a little more anteriorly. Dentigerous ridges are present, at least on the anterior processes of the lips. The teeth are very small. Interlabia are absent. The oesophagus has a straight posterior glandular portion, or ventriculus, of oblong shape. The distance from the head end to the posterior end of the ventriculus is 2.3-2.7 mm. The ventriculus is 0.6 mm. long in the male,

0.75-0.78 mm. in the female. The anterior caecal prolongation of the intestine measures 0.95-1.3 mm. in length. There is a pair of prominent, rounded, cervical papillae at 0.65-0.67 mm. from the anterior end. The nerve-ring is situated at 0.46-0.53 mm. from the same point. The excretory system terminates, as usual in the genus, in a long unicellular gland with a very narrow duct leading to the excretory pore, which is situated just between and behind the ventro-lateral lips.

The tail of the male (figs. 14, 15) is conical, slightly curved ventrally, and measures 0.38 mm. in length. There are slight caudal alae, and most of the papillae have rather long, rib-like pulps. There are about 40 pairs of preanal papillae, and in addition to these there is one median sessile papilla on the anterior lip of the cloaca. One pair of papillae, apparently belonging to the preanal series, is situated just at the corners of the cloacal opening. There are seven pairs of postanal papil-

lae, of which the second and third from the tip of the tail are laterally, the rest ventrally situated. The fifth papilla on either side is larger than the rest, and has double terminations. The spicules are equal, simple and without alae. They measure only 0.9 mm. in length.

The tail of the female is bluntly conical and measures 0.44 mm. in length. The caudal papillae are situated at 0.162 mm. from the tip. The vulva is somewhat be-

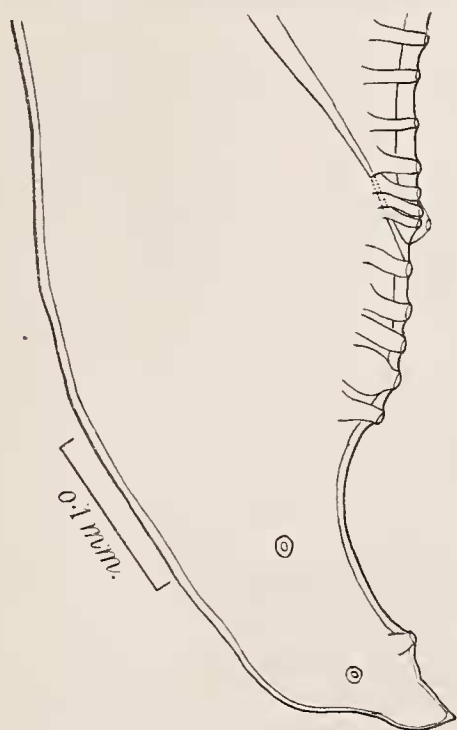


FIG. 14.—*Porrocaecum pristis*. Tail of male; lateral view.

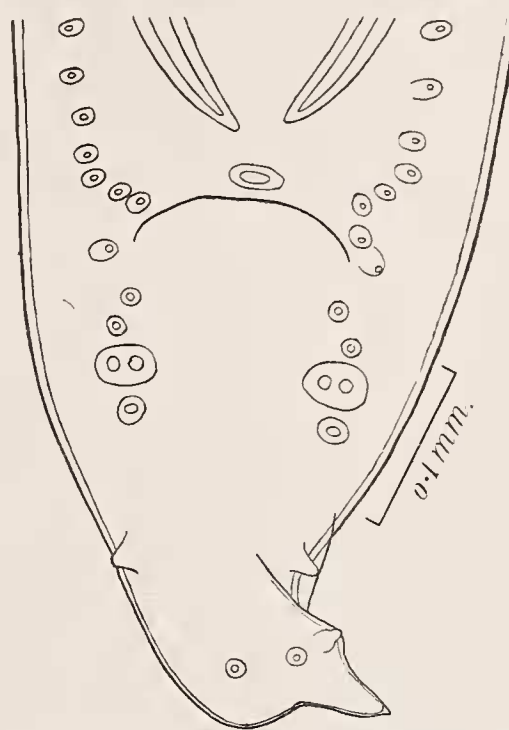


FIG. 15.—*Porrocaecum pristis*. Tail of male; ventral view.

hind the anterior third of the body—at 12.3 mm. from the anterior end in a specimen 34.2 mm. long. The muscular vagina, which runs posteriorly, is very short (about 0.7 mm.), expanding in its posterior half to a diameter of 0.19 mm. This swollen portion is packed with ova. Then follows a wide uterine reservoir, about 2 mm. long, which gives off posteriorly the two uterine branches. These run almost straight towards the posterior end. The posterior limit of the coils of the ovarian tubes is about 1.5 mm. from the posterior end. The ova are spherical, with a thin shell, measuring 0.0475 mm. in diameter. The content of the egg is unsegmented when ready for laying.

*Ascaris circularis* v. Linst. is recorded as a parasite of *Pristis antiquorum* in the Cameroon. Von Linstow (1907), in his description of it, mentions the presence of an intestinal caecum, and it is not improbable that the species also belongs to the genus *Porrocaecum*. But the figure of the dorsal lip (*l. c.*, pl. 6, fig. 1) is sufficient to differentiate it from *P. pristis*.

#### Genus *Contracaecum*, Railliet and Henry, 1912.

##### *Contracaecum spiculigerum* (Rud., 1809).

##### Hosts:

Little cormorant (*Phalacrocorax javanicus*).

Indian shag (*Phalacrocorax fuscicollis*).

**Contracaecum rosarium** (Connal, 1912).

(Fig. 16.)

The collection contains worms taken on two occasions from the night-heron (*Nycticorax griseus*). The material consists in one case of two immature males, the tails of which are eroded and useless for purposes of identification, and in the other case of three immature females and one rather damaged, immature male. We have

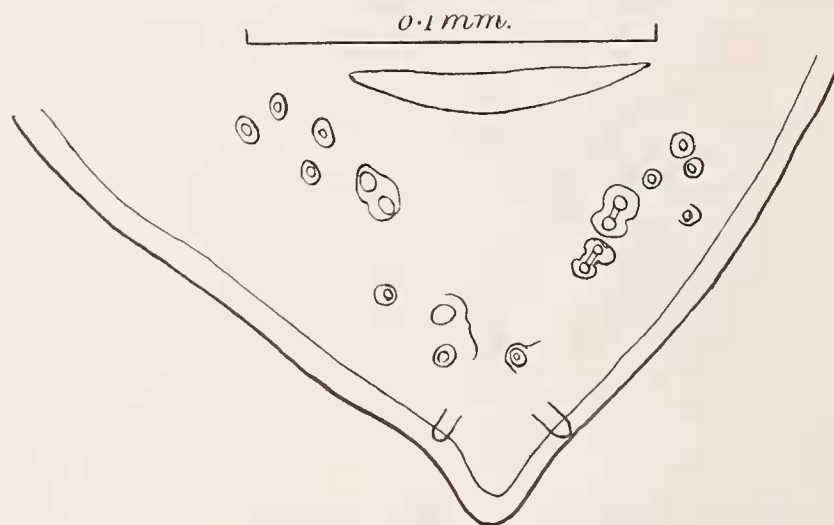


FIG. 16.—*Contracaecum rosarium*. Tail of male; ventral view.

assigned these to *Contracaecum rosarium*. There is nothing in Connal's (1912) description to indicate a difference between his species and *C. microcephalum* (Rud.), except that there are three pairs of postanal papillae in the male. With the material at our disposal it is not possible to redescribe the species. The head generally and the dorsal lip in particular are indistinguishable from those of *C. microcephalum*. However, the tail of the male in the second set shows quite clearly that there are more than three pairs of postanal papillae, and that the number and arrangement of these papillae (which, in the only specimen available, are unfortunately somewhat asymmetrical), will serve to differentiate this species from *C. microcephalum*. There are nine pairs of postanal papillae. Those of the pair at the tip are stalked and nipple-like, while the remainder are flattened. The fifth pair have double terminations.

Our best thanks are due to Dr. L. Gedoelst, of Brussels, for kindly obtaining for us the loan of the type-material of *Kathleena arcuata*, Gedoelst, 1916, the property of the Congo Museum at Tervueren. One of us (Baylis, 1920 a) had already suggested that this form was probably identical with *Contracaecum microcephalum* (Rud.), and our examination of the material confirms this view.

**Contracaecum incurvum** (Rud., 1819) (?).Syn. *Ascaris incurva*, Rud.

(Figs. 17, 18.)

Two male individuals of an Ascarid from the stomach of the peacock fish (*Histiophorus gladius*) are probably referable to this species, though they are small and perhaps not fully mature. The characters of the oesophagus and of the head



show them to belong to the genus *Contracaecum*. The head corresponds fairly well with the figures given by Schneider ((1866), pl. II, figs. 11 *a* and *b*) and by Linton ((1901), pl. IV, figs. 29, 30), while the presence of a long intestinal caecum has been noted by Dujardin (1845) and by Linton (*l. c.*), although the oesophageal appendix was not observed, and Dujardin placed the species among the forms now considered to belong to the genus *Porrocaecum*.

The characters of the caudal end in the male do not appear to have been accurately described. Stossich ((1902), pl. III, fig. 1) shows only two pairs of postanal papillae, and a peculiarly shaped tail. Linton's figure ((1901), pl. IV, fig. 32) is scarcely adequate for determination. For these reasons it may be

worth while to give some details and figures of the anatomy of the present specimens.

The larger of the two specimens measures 34.3 mm. in length and 0.55 mm. in thickness. The diameter of the head is about 0.19 mm. The distance from the head end to the posterior end of the oesophagus (including the small spherical ventriculus) is about 3 mm. The ventriculus is 0.16 mm. in diameter. The oesophageal appendix is relatively very long (3 mm.), and the intestinal caecum runs forward to a point 1.05 mm. from the head end. The cervical alae originate just dorsally to the lateral interlabia, and extend back to a point about 2 mm. from the anterior end. They are about 0.05 mm. wide at the widest part. The body is relatively slender and of almost uniform thickness throughout. The cuticular striations are coarse (up to 0.0125 mm. apart), and form small saw-teeth in optical section. The lips have sinuous margins anteriorly and laterally, and are produced into broad cuticular flanges at the posterior corners. There are deep grooves running round the bases of the lips from the interlabia, similar to those characteristic of the genus *Ophidascaris*. The interlabia are rather short and compressed between the lips. The ventro-lateral lips are somewhat asymmetrical in shape, though hardly so much so as is indicated by Schneider's figure ((1866), pl. II, fig. 11 *b*), the ventral angles being considerably produced. The dorsal lip bears a pair of rather small, rounded papillae; the ventro-lateral lips one each, towards the ventral side. There is a pair of conspicuous, but sessile, cervical papillae situated dorsally to the cervical alae and at 0.65 mm. from the anterior end. The nerve-ring is at 0.55 mm., and the excretory pore at 0.68 mm., from the anterior end.

The tail of the male (fig. 18) is 0.2 mm. long, sharply tapering, curved ventrally and drawn out at the tip into a slender spike. There are no caudal alae. The ventral surface of the caudal region, from about 0.7 mm. in front of the cloaca forward

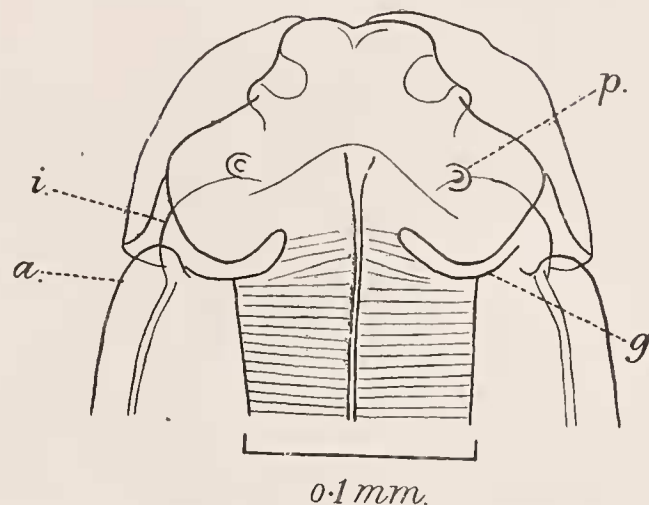


FIG. 17.—*Contracaecum incurvum*. Head of male; dorsal view.

*a.*, cervical ala; *g.*, groove in cuticle; *i.*, interlabium; *p.*, papilla.

for about 2 mm., has the cuticle raised into pronounced longitudinal ridges, interrupted by transverse grooves at intervals of 0.03 mm. The spicules are equal in

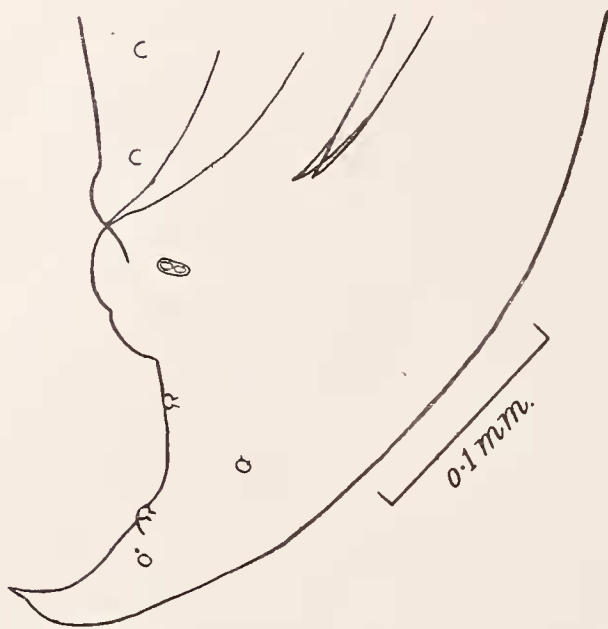


FIG. 18.—*Contracaecum incurvum*. Tail of male; lateral view.

length (4.1 mm.) and have broad alae, except for a short distance at the tip. The caudal papillae are all rather small and sessile. There are about 15 pairs of preanal papillae, those near the cloaca small and close together, the more anterior gradually becoming larger and wider apart. There is also a pair of double adanal papillae, and four postanal pairs, of which two are ventral and two lateral.

The host in which the adult form of this species has been commonly recorded is the sword-fish, *Xiphias gladius*,<sup>1</sup> and the worm appears to be very widely distributed and to attain a large size. Linton (1901) has also recorded immature stages, probably of this species, from several other fishes. In the pre-

sent collection there are included some encapsuled larvae from the mesentery of *Nandus marmoratus* and *Wallago attu*, and from the body-cavity and peritoneum of another (unnamed) fish, which show the same oesophageal structure as the specimens from *Histiophorus*, and are perhaps to be referred to the same species. The largest of these larvae is about 33 mm. long. The oesophagus does not yet exceed 3 mm. in length, and the oesophageal appendix 0.5 mm. The intestinal caecum is already of considerable length. The lips are not yet formed, so that it is impossible to confirm the determination by a study of their structure.

### *Contracaecum tricuspe* (Gedoelst, 1916).

This species was described by Gedoelst from an African heron. We have to record its appearance at Calcutta in the Indian darter or snake-bird (*Plotus melanogaster*).

### *Contracaecum engonium*, sp. nov.

(Figs. 19, 20.)

A single male specimen was collected from the black stork (*Ciconia nigra*). It measures 13 mm. in length and 0.57 mm. in maximum thickness. The head measures 0.19 mm. in diameter, and is constricted off from the body. The interlabia are simple and undivided at the tip. The dorsal lip (fig. 19) is rounded anteriorly and carries a pair of double papillae. The pulp roughly follows the shape of the lip, but is indented on its anterior edge. Each lip is provided with a pair of flattened processes springing from the internal surface and projecting anteriorly like two small horns at the shoulders of the lip. The muscular portion of the oesophagus measures

<sup>1</sup> *Histiophorus gladius*, though probably related, not distantly, to *Xiphias*, is not the same fish, and appears to be a new host.

2.75 mm. in length and 0.14 mm in thickness. The intestinal caecum is broad, and reaches to within 0.69 mm. of the head-end. There is a short ventriculus, measuring about 0.14 mm. in length and about as broad as long. From this is given off a posterior caecum which is 0.7 mm. in length and 0.15 mm. in thickness.

The spicules are equal, long and slender, measuring 1.8 mm. in length and 0.022 mm. in breadth. They consist of a cylindrical shaft with narrow lateral alae. The cloaca is situated at 0.125 mm. from the tip of the tail (fig. 20), which is abruptly attenuated to a conical point. There are ten pairs of post-anal papillae, of which the first, fourth, fifth and seventh are latero-ventral. The remaining six pairs are lateral and pedunculate, and fall into two groups: a group

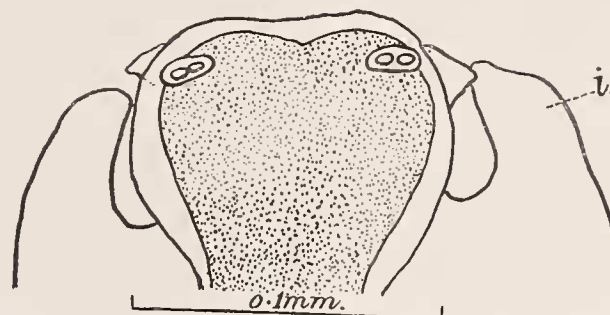


FIG. 19.—*Contracaecum engonium*. Head of male: dorsal view.

*i.*, interlabium.

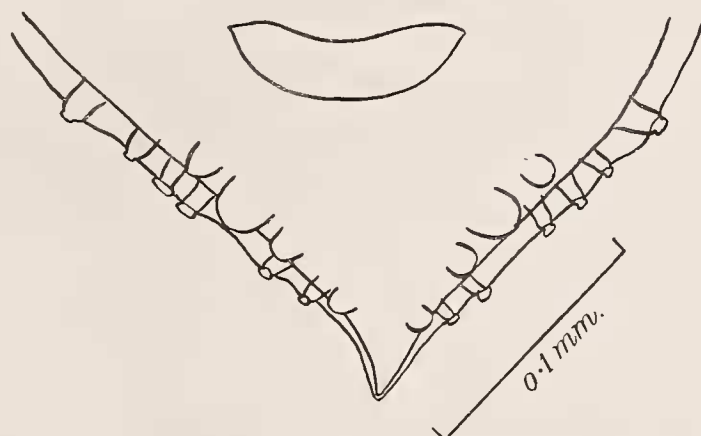


FIG. 20.—*Contracaecum engonium*. Tail of male: ventral view.

of two pairs (the second and third) close to the tip, and a group of four pairs extending from about the middle of the tail almost to the cloaca.

### ***Contracaecum schizothoracis*, sp. nov.**

(Figs. 21, 22.)

Host: *Schizothorax zarudnyi*.\* Position: intestine. Locality: Hamun-i-Helmand, Seistan, Eastern Persia.

This is a relatively short and stout species, tapering to a considerable degree at each end. The male is 16.75 mm. long and 0.8 mm. thick; the female 20.2 mm. and 1.0 mm. respectively. The cuticular striations are 4–5 $\mu$  apart. The diameter of the head is 0.2–0.22 mm. The lips (fig. 21) are small, with a deep indentation in the middle of the anterior margin, cuticular flanges at the sides, and a projection on the inner surface at each anterior angle. The dorsal lip bears two large, lozenge-shaped papillae, the ventro-lateral lips one each towards the ventral side. The interlabia



(fig. 21, *i.*) are almost as long as the lips, and are bifurcate at the tip. There are no cervical alae. The distance from the head-end to the posterior end of the oesophagus (including the small, almost globular ventriculus) is 2.2–2.5 mm. The ventriculus measures 0.18 mm. in length and 0.24 mm. in width. The oesophageal appendix is

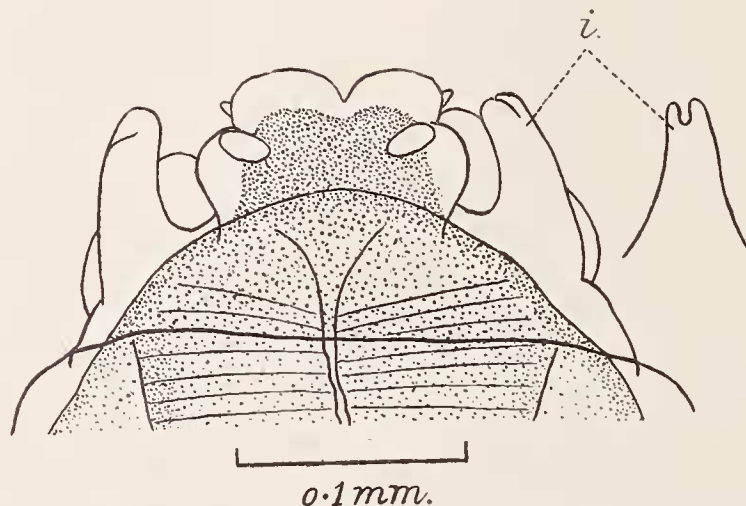


FIG. 21.—*Contracaecum schizothoracis*. Head of female; dorsal view.  
*i.*, interlabium.

about 0.6–0.7 mm. long, and the intestinal caecum runs forward to a point about 0.5 mm. from the head-end. The prominent cervical papillae and the nerve-ring are situated at 0.3–0.4 mm. from the anterior end. The position of the excretory pore was not made out.

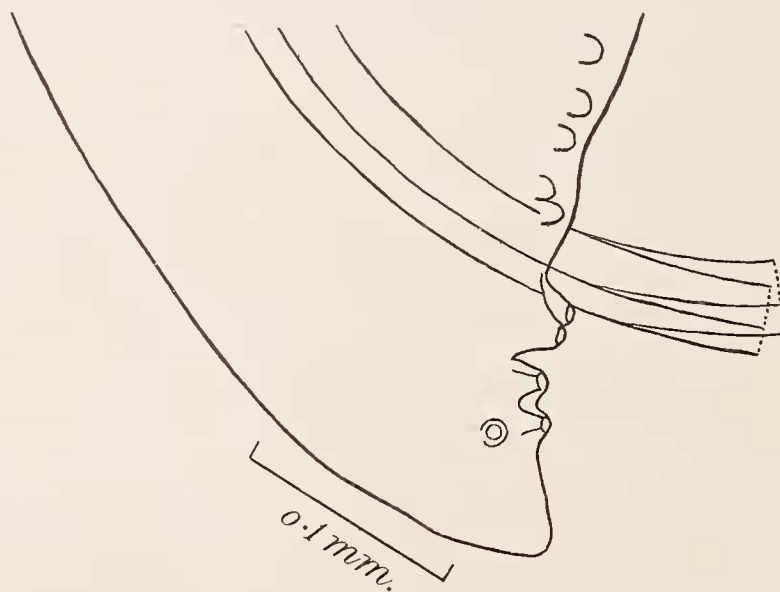


FIG. 22.—*Contracaecum schizothoracis*. Tail of male; lateral view.

The tail in both sexes is short and bluntly conical. In the male, it is 0.12 mm. long and has no alae. The spicules are very long (at least 5.5 mm.) and provided with broad alae. Their length could not be accurately measured owing to the whole of the extruded portion being thrown into spiral coils. Their dorso-ventral diameter is about 0.035 mm. There is a regular series of about 23 pairs of small preanal

papillæ. The postanal papillæ are arranged in five pairs, of which the most posterior is lateral, the rest ventral. The two anterior pairs are at almost the same transverse level, just opposite to the posterior lip of the cloaca.

The tail of the female is 0.23 mm. in length. No caudal papillae were seen. The vulva is situated a little behind the anterior fifth of the body (at 4.3 mm. from the anterior end). The simple muscular vagina, after a preliminary coil anteriorly, pursues a very irregular course posteriorly to about 1.5 mm. from the vulva before the origin of the uterine branches. These are about 8 mm. in length, their posterior ends serving as receptacula seminis. The ovarian tubes appear to double upon themselves some distance in front of the anus, and return towards the anterior end. The ova are nearly spherical, with a thick shell measuring 0.0575–0.0725 mm. in diameter.

Genus *Amplicaecum*, Baylis, 1920.

*Amplicaecum varani*, sp. nov.

(Figs. 23, 24.)

A few specimens of an Ascarid which appears to belong to the genus *Amplicaecum* were collected on one occasion from the intestine of *Varanus salvator* in the Zoological Garden. The only Ascarid hitherto recorded in *Varanus*,<sup>1</sup> so far as we are able to discover, is *Ophidascaris filaria*, which is, however, usually found in pythons. This is a much larger species, and could not be confused with the present form.

There were several adult males, but unfortunately only one fully mature female. The measurements in the following description were taken from this female and the three largest males.

The male measures 22.2–24.9 mm. in length, the female 24.75 mm. The greatest thickness is 0.73 mm. in the male, 0.8 mm. in the female. The diameter of the head is 0.25–0.29 mm. The cuticular striations are fine (about 0.005 mm. apart).

The lips (fig. 23) are nearly square in shape, and have a deep indentation on the inner surface at the anterior margin. The interlabia are very small and almost hidden by the lips. From the interlabia well-marked semicircular grooves in the cuticle run round the bases of the lips, nearly meeting in the median line of each lip. These grooves have upstanding membranous cuticular borders posteriorly. The dorsal lip has two moderately large papillæ. Each ventro-lateral lip has one large, lozenge-shaped papilla towards the ventral side, and one very small papilla laterally. The dentiger-

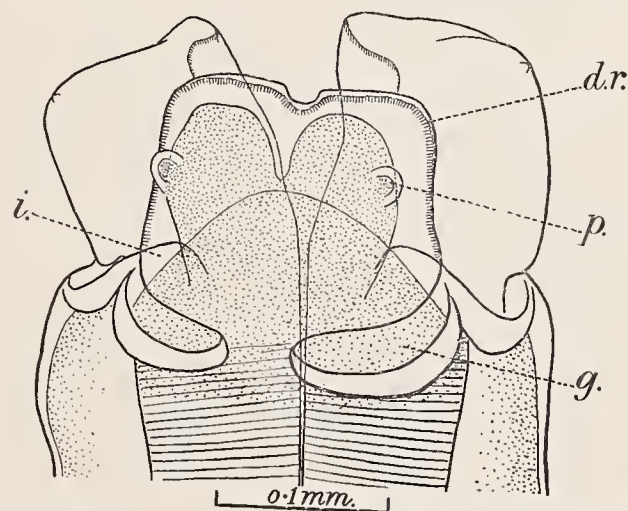


FIG. 23.—*Amplicaecum varani*. Head of female; dorsal view.

*dr.*, dentigerous ridge; *g.*, groove in cuticle; *i.*, interlabium; *p.*, papilla.

<sup>1</sup> See Baylis (1921).

ous ridges are well-developed and marginal. The oesophagus is without bulb or ventriculus, and measures 3.5–4.7 mm. in length. A well-developed, but rather

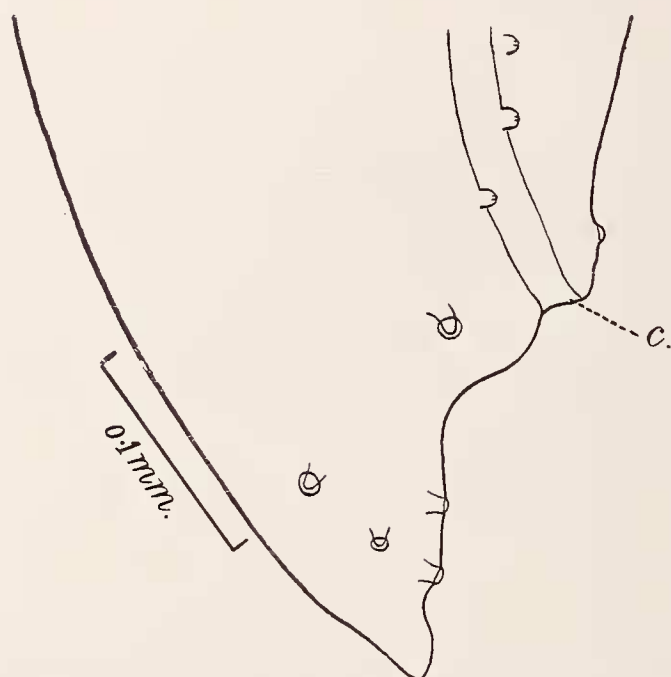


FIG. 24.—*Amplicaecum varani*. Tail of male; lateral view.

c., cloacal aperture.

narrow, intestinal caecum, 0.9–1.0 mm. long, is present, running forward beside the oesophagus. The very small cervical papillae are situated at about 0.9 mm. from the anterior end, the nerve-ring at 0.7–0.74 mm., and the excretory pore at 0.9 mm., from the same point.

In the male, the conical tail (fig. 24) is only 0.16 mm. long, and there are no caudal alae. The two equal spicules are remarkably short (0.5 mm.) and are simple, cylindrical, slightly tapering rods. There are some 32 pairs of preanal papillae, those nearest to the cloaca being very small, the more anterior much larger. In addition to these there is one small, sessile, median papilla on the anterior lip of the cloaca. The postanal papillae are arranged in five pairs, of which the first

and third from the tip of the tail are ventral, the rest lateral, in position.

In the female, the tail is conically pointed and 0.32 mm. long. There is a pair of caudal papillae at 0.065 mm. from the tip. The vulva is situated at 6.5 mm. from the anterior end of the body, *i.e.*, a little behind the anterior quarter. There is a long muscular vagina, following a very irregular course in a generally posterior direction, but with occasional forward loops. The two uterine branches are wide and thin-walled, and run backward with a rather sinuous course. The coils of the ovaries occupy the posterior region of the body, as far back as about 1.5 mm. from the tip of the tail. The eggs are oval, with a rather thin shell, measuring 0.0675–0.075 × 0.05 mm.

Genus *Dujardinia*, Gedoelst, 1916.

*Dujardinia helicina* (Molin, 1860).<sup>1</sup>

We refer to this species two immature females from the stomach of *Crocodilus porosus* from Port Canning, Gangetic Delta. The specific determination is possibly

<sup>1</sup> Gedoelst (1916) describes a form, from an African crocodile, which he identifies with *A. helicina*, Molin, erecting for it a new genus *Dujardinia*. Skrjabin (1916) also describes what he believes to be *A. helicina*, Molin, from an African crocodile, and proposes for it the new genus *Trispiculascaris*. Travassos (1920) considers both Gedoelst's and Skrjabin's species distinct from *A. helicina*, Molin, and renames Gedoelst's form *Dujardinia dujardini*, and that of Skrjabin *Trispiculascaris trispiculascaris*. As, however, this author gives no morphological reasons for his views, we are unable to discuss them. Examination of African material existing in the British Museum, and already regarded as *Dujardinia helicina* (Molin) of Gedoelst, shows that the oesophageal and intestinal structure described by Gedoelst is present. This is definitely stated by Skrjabin to be absent in his material. On the other hand, an accessory piece similar to that



open to doubt. *Ascaris helicina* was originally described from *Crocodylus acutus*<sup>1</sup> in America, but has also been recorded from Africa in *Crocodylus niloticus* more than once, though not hitherto from an Indian crocodile.

### Larvae of Anisakinae.

Immature Ascarids of various sizes (the longest measuring about 18 mm.) occurred under the peritoneum of the fish *Pelamys chiliensis*. They have a long ventriculus, and may be the larvae either of an *Anisakis* or of a *Porrocaecum*. If the latter, the intestinal caecum has not yet been developed.

Family HETERAKIDAE, Railliet and Henry, 1914.

Subfamily HETERAKINAE, Railliet and Henry, 1912.

Genus *Heterakis*, Duj., 1845.

*Heterakis papillosa* (Bloch, 1782).

Syn. *H. vesicularis* (Frölich, 1791).

The collection contains examples of this species from the following hosts:

Ring-necked pheasant (*Phasianus torquatus*\*).

Common hill-partridge (*Arboricola torqueola*).

*Heterakis isolonche*, v. Linst., 1906.

Hosts:

Crimson horned pheasant (*Tragopan satyra*).

Monál (*Lophophorus impeyanus*).

Blood pheasant (*Ithagenes cruentus*).

An accurate description of this species has been given by Lucet and Henry (1911). The remarkable cuticular "papillae" usually present in the neighbourhood of the vulva of the females are not constant in number or position, and some individuals have none. Moreover, they correspond very closely in diameter with the internal diameter of the preanal sucker of the male. We are therefore inclined to believe that they are actually caused by the action of the sucker of the male in attempting to copulate. It may be that the cuticle of this part of the ventral surface of the female is soft and readily drawn into the sucker. In any case, these raised "hold-

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described by Skrjabin is also present. The spicules are of great relative length and very slender. Geddoelst gives the length of the spicules as 280 $\mu$ , and does not mention an accessory piece. 280 $\mu$  is slightly less than the length of the accessory piece in our material, and we suggest that this structure has been mistaken for the spicules. We are therefore inclined to believe that our material and Geddoelst's belong to the same species, but that the form described by Skrjabin is distinct, unless the important structure of the alimentary canal has been overlooked. The structure of the oesophagus and the presence or absence of diverticula of the alimentary canal are characters which we regard as of considerable systematic value among the Ascaridae; but, as has been shown above (see *Porrocaecum reticulatum*) an accessory piece may occur in an isolated species of a genus in which it is normally absent, and we do not feel that it is of equally great systematic importance.

We wish here to acknowledge our indebtedness to Prof. R. T. Leiper for kindly assisting us to consult Skrjabin's paper.

<sup>1</sup> More correctly, *C. americanus*.

fasts" would be very effective in assisting close union if, as we suggest, they are embraced by the sucker.

***Heterakis longecaudata*, v. Linst., 1879.**

This species, which is very closely related to the genotype, *H. papillosa*, appears to have been recorded up to the present only in its type-host, *Megacephalon maleo*, a bird of the Megapodiid family, found in Celebes. It is not improbable, however, that its exceedingly close resemblance to *H. papillosa* has led to its being often confused with that species when found in other hosts. In the Zoological Garden, Calcutta, it occurred in the following birds:—

Monál (*Lophophorus impeyanus*).

Crimson horned pheasant (*Tragopan satyra*).

Swamp-partridge (*Francolinus gularis*).

Red spur-fowl (*Galloperdix spadicea*).

In the two first-mentioned hosts it appears to occur not uncommonly, though in small numbers, if we may judge from the small amount of material available. In the horned pheasant it sometimes occurred together with *H. bosia* or *H. isolonche*, or both. In the monál both *longecaudata* and *isolonche* occur, but we have not found them together.

It may be useful to amplify somewhat the short original description given by von Linstow (1879). The measurements here given are based on examples from the monál.

The length of the male is from 7.9 to 9.1 mm., that of the female 7.9 to 9.6 mm. The maximum thickness, measured dorso-ventrally, is 0.3–0.4 mm. The cuticular striation is so fine as to be scarcely visible in some specimens. The anterior end of the worm is usually curved towards the dorsal side. The three lips are simple and very similar to those of *H. papillosa*. The diameter of the head at the base of the lips is 0.08 mm. There are well-developed lateral alae, commencing at a short distance from the head, and running throughout the greater part of the length of the body. At 0.55 mm. from the anterior end a pair of small cervical papillae project into the alae. The oesophagus, measured from the anterior end of the worm to the back of the bulb, is 1.0–1.1 mm. long. It commences with a small anterior section, or "pharynx," narrower than the oesophagus proper and 0.08–0.09 mm. long. Posteriorly the oesophagus passes gradually into a large, pear-shaped bulb, 0.18–0.22 mm in diameter, and containing a well-developed valvular apparatus. The nerve-ring is situated at 0.3 mm., and the excretory pore at 0.45–0.5 mm., from the anterior end.

In the male, the caudal end is provided with very broad alae. The tail proper (*i.e.*, the postanal portion) measures 0.45–0.5 mm. in length, and tapers beyond the alae to a fine filament. The preanal sucker measures 0.08–0.09 mm. in diameter, and is situated at 0.1–0.15 mm. from the cloaca. Both spicules are alate, the alae of the short left spicule being very broad, those of the long right spicule much narrower. The shorter spicule has a double bend near the tip. like that of *H. papillosa*, while the

tip of the longer spicule is simple and straight. The lengths of the spicules are 2.38 mm. and 0.75 mm. respectively in a large specimen. The twelve pairs of caudal papillae are arranged in the manner indicated by von Linstow, with the exception that of the two pairs nearest to the posterior end one is situated laterally, the other (slightly larger) ventrally, and both are at an equal distance from the tip of the tail. In number and arrangement there is therefore no difference from *H. papillosa*.

In the female, the tail is straight and gradually tapering, and measures 1.1-1.2 mm. in length. There is a conspicuous pair of caudal papillae at about 0.68 mm. from the posterior end. The vulva is situated very slightly behind the middle of the body (not in front of it, as stated by von Linstow), viz., at 3.7-4.75 mm. from the posterior end. The vagina is long, and pursues a complicated course almost precisely similar to that of *H. papillosa*. The terminal portion (ovjector) runs posteriorly from the opening. The tube then makes a sharp turn anteriorly, then a curve to the right and dorsally, then bends posteriorly, and from this point runs straight back to a point about 1.5 mm. from the anus. Here it doubles upon itself, and at about 1 mm. behind the vulva gives off the two apparently opposed uteri. The greater part of the coils of both ovaries lie in the anterior portion of the body, between the vulva and the posterior end of the oesophagus. The ova are somewhat oblong, with a thick shell, which is slightly dimpled at each pole.

They measure about  $0.075 \times 0.0425$  mm.

Perhaps the most reliable character by which this form can be distinguished from *H. papillosa* is the larger size of the preanal sucker in the male—(outside diameter 0.06-0.07 mm. in *papillosa*, 0.08-0.09 mm. in *longicaudata*). The spicules are also a little longer, the right spicule being longer than that of any other species recorded in Galliform birds. The preanal sucker is, as a rule, situated somewhat nearer to the cloacal aperture than in *H. papillosa*, and the caudal alae of the male are broader. On placing examples of the two species side by side, the males are fairly readily separable, but it would be difficult to find characters by which the females could be easily distinguished.

#### **Heterakis bosia**, Lane, 1914.

This interesting form, the male of which is easily distinguished from that of other species by the peculiar shape of its left spicule, was found frequently in the crimson horned pheasant (*Tragopan satyra*). Although evidently common, it does not appear to give rise to heavy infections. It occurred once in association with *H. longicaudata* only, and once with both this species and *H. isolonche*.

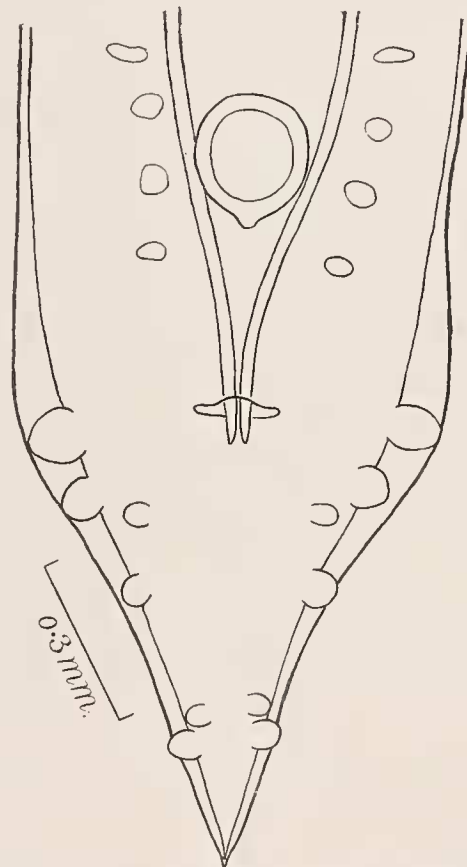


FIG. 25.—*Ascaridia perspicillum*. Tail of male; ventral view.



Genus *Ascaridia*, Duj., 1845.

*Ascaridia perspicillum* (Rud., 1803.)

(Fig. 25.)

Hosts:

Common fowl.

Blood pheasant (*Ithagenes cruentus*).

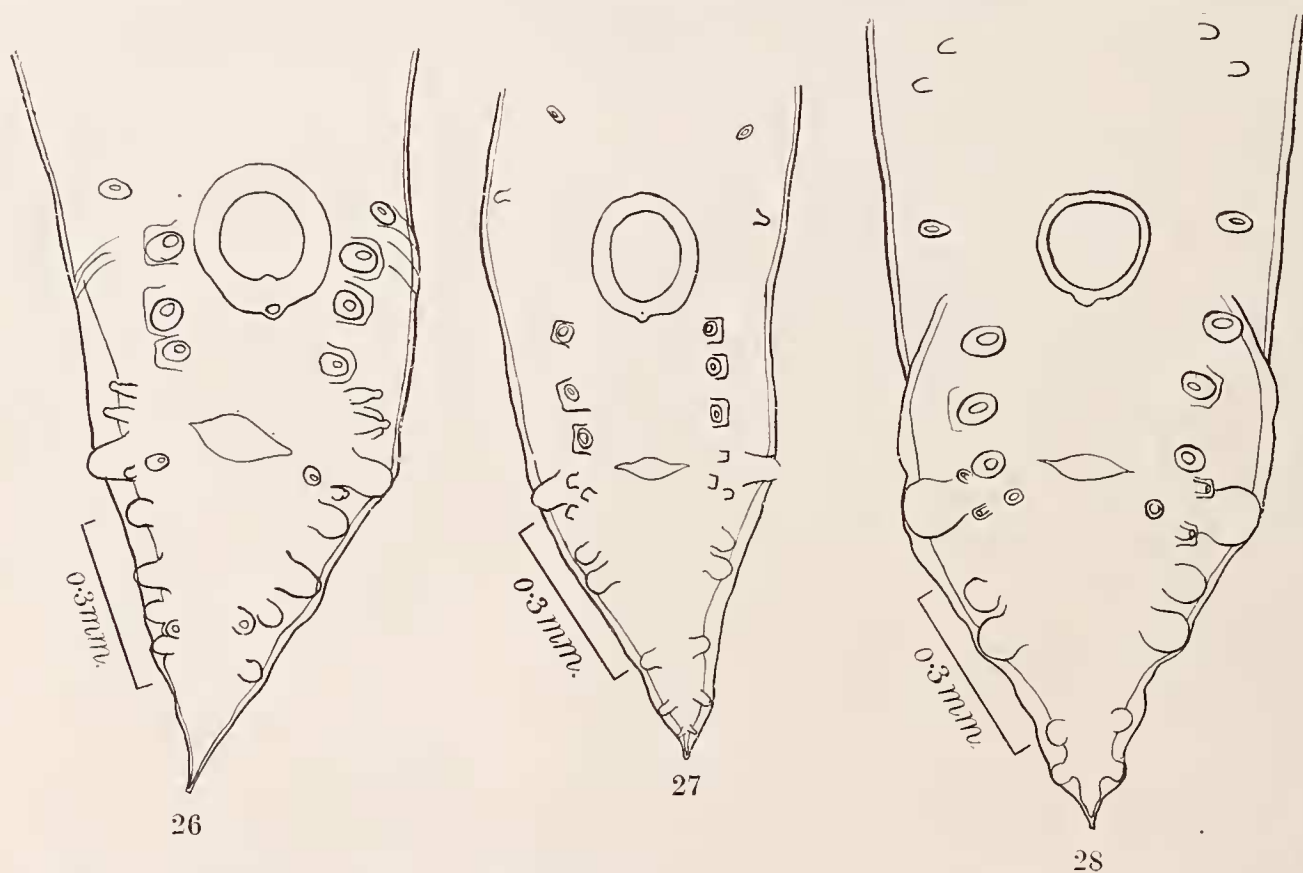
In view of the scarcity of figures of the male tail we furnish a new one (fig. 25).

*Ascaridia columbae* (Gmelin, 1790).

(Figs. 26-28.)

Syn. *Heterakis maculosa* (Rud., 1802), Schneider, 1866.

Specimens which we assign to this species were collected from the Bengal green pigeon (*Crocopus phoenicopterus*) on three occasions, and from *Phlogoenas luzonica* and other pigeons. Some difficulty was at first experienced in definitely determining these specimens, owing to the variations not infrequently encountered in the position and



FIGS. 26, 27, 28.—*Ascaridia columbae*. Tails of three males, in ventral view, to show variation in papillae.

number of the caudal papillae of the male. Actually the typical number of papillae is 14 pairs, which is the number given by von Linstow (1901 *a*), but the figure of this author is rather too diagrammatic to show clearly their arrangement.

There are five pairs of distinctly postanal papillae, the third pair of which is rather ventrally placed, while the remainder are lateral. There is an adanal group of

four pairs, one pair of which is large and laterally placed, the remaining three pairs being small and arranged in a triangle on the ventral surface. There is a series of three pairs of preanal papillae on the ventral surface between the cloaca and the posterior margin of the sucker. Near the level of the anterior margin of the sucker is another pair more laterally placed, and finally there is a pair placed anteriorly to the sucker. This last pair may be duplicated (fig. 28). Another variation may be furnished by the presence of an additional pair of papillae in the row between the sucker and the anus (fig. 26). Not infrequently also, the most posterior pair of postanal papillae appears to be absent (fig. 28). The spicules are equal and measure from 1.2 to 1.35 mm. in length.

An additional character of *A. columbae* which has, so far as we are aware, hitherto escaped notice, is the presence of 26 to 30 pairs of cervical papillae extending backwards from near the posterior end of the cephalic alae, the first two or three pairs being situated in the alae.

The species varies greatly in size, the males in our material measuring from 60 to 70 mm. in length and about 1.1 mm. in thickness; the females from 70 to 95 mm. and up to 2.5 mm. respectively.

### *Ascaridia compar* (Schränk, 1790).

(Fig. 29.)

This species has been recorded in *Caccabis saxatilis*, *Coturnix dactylisonans*, *Coturnix communis*, *Ortyx virginianus*, *Perdix cinerea*, *Tetrao urogallus*, *T. lagopus*, *T. tetrix*, *Gallus gallinaceus*, *Gallus domesticus*, *Numida meleagris*, and *Colinus virginianus*.

We have now to record its occurrence in the Chakor (*Caccabis chucar*).

The material agrees in all essential features with the descriptions given by v. Linstow (1899) and by Müller (1897), though the figures of the tail of the male given by both these authors are not quite accurate. Müller, indeed, describes the post-anal papillae correctly, but his figure fails to indicate clearly the number and arrangement of the small papillae near the tip of the tail. It may therefore not be out of place to give in the present paper a new figure (fig. 29).



FIG. 29.—*Ascaridia compar*. Tail of male; ventral view.

### *Ascaridia cristata* (von Linstow, 1901).

(Fig. 30.)

This species was described by von Linstow from material taken from *Balearica regulorum*. We have to record its occurrence in the West African crowned crane (*Balearica pavonina* \*) and in the sarus (*Grus antigone*). We propose to amplify somewhat the original description.

The females measure from 38 to 40 mm. in length and 1.1 to 1.2 mm. in thickness; the males about 35 mm. and 1.1 mm. respectively. The head measures from

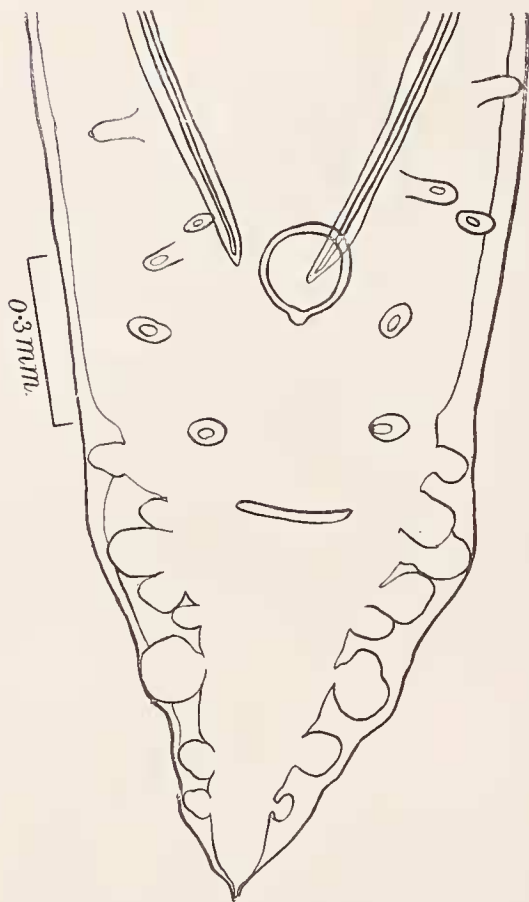


FIG. 30.—*Ascaridia cristata*. Tail of male; ventral view.

0.27 to 0.28 mm. in diameter. The dorsal lip is shorter and broader than the two ventro-lateral lips, and carries two papillae. The oesophagus measures from 2.1 to 2.3 mm. in length, and is encircled by the nerve-ring at a distance of 0.46 mm. from the head. The excretory pore opens at about 0.69 to 0.7 mm. from the anterior end. A series of 27 pairs of cervical papillae, similar to those described in *A. columbae* above, extends from a point about 0.9 mm. from the head backwards for a distance of 6.0 to 6.5 mm. The anterior pairs are placed just dorsally to the cervical alae, and the distance between successive pairs varies from 0.15 to 0.3 mm. The tail of the male is furnished with 13 pairs of papillae, of which 7 are postanal and 6 preanal. Von Linstow (1901 *b*) described 7 postanal pairs and 2 preanal, while Gedoelst (1916) in assigning specimens to this species describes 3 pairs of preanal papillae. The arrangement of the papillae in our material is shown

in fig. 30. Gedoelst also mentions that the sucker does not possess the "unpaired papilla" on its posterior border. In the specimens we have examined this structure was easily detected in some and in others apparently absent. The spicules are long and slender and measure 0.95 mm. in length and 0.042 mm. in width. They are alate. The anus is situated at about 0.62 mm. from the tip of the tail.

The vulva of the female is situated about 20 mm. from the anterior end, and is slightly salient. There is a short transverse vagina. The ova measure 0.085 × 0.058 mm. The tail measures 0.7 mm. in length.

#### ***Ascaridia stroma*** (von Linstow, 1899).

Von Linstow described this species from *Grus paradisea*. The present collection furnishes us with specimens from the common crane (*Grus communis*) and the sarus (*Grus antigone*).

Genus **Strongyluris**, A. Müller, 1894.

**Strongyluris chamaeleonis**, sp. nov.

(Figs. 31-33.)

Host: *Chamaeleon vulgaris*\* (Zoological Garden, Calcutta).

This is a small species, measuring 6.3 mm. in length in the male, 8.4-8.75 mm. in



the female. The maximum thickness is 0.5–0.7 mm. The lateral fields are broad, and of the type characteristic of the genus, consisting of a single row of some 70 large, granular cells with clear, rounded nuclei. There are no lateral alae. No cervical papillae have been detected, nor do the longitudinal rows of small papillae on the body, which occur in some species, appear to be present in either sex. The cuticular striation is exceedingly fine. The diameter of the head is about 0.06 mm. There are three distinct lips, of somewhat elongate shape, each terminating anteriorly in a flattened lobe consisting only of cuticle, which, seen in profile (fig. 31), gives the lip the appearance of ending in a kind of curved tooth or spine. Each lip bears a relatively large papilla on the outer surface of its basal portion. The oesophagus, as has been observed in some other members of the genus, is marked off into a narrow anterior portion, or pharynx, the lumen of which describes a peculiar ventral bend posteriorly; and a wide posterior portion, the oesophagus proper, ending posteriorly in a well-developed bulb. The distance from the anterior extremity of the lips to the posterior end of the oesophageal bulb is about 1.1 mm. in the male, 1.45 mm. in the female. Of this the pharynx occupies 0.18–0.22 mm. The bulb is almost spherical, measuring 0.2–0.25 mm. in both antero-posterior and transverse directions. The nerve-ring is situated at 0.37–0.39 mm., and the excretory pore at 0.6–0.85 mm., from the anterior end.

The caudal end of the male (figs. 32, 33) is obliquely truncate, terminating in a small, conical spike. Anteriorly to this there are broad alae, forming an almost circular bursa-like expansion. Near the anterior limits of the alae there is a rounded sucker with chitinous ring, measuring 0.09 mm. in outside diameter, and having its aperture somewhat posteriorly directed. There is a little depression in the posterior edge of the chitinous ring, as in *Heterakis*. This has been described as a papilla in some species. The two equal spicules, which measure 1.1 mm. in length and 0.0275 mm. in maximum thickness, are covered externally with rather coarse granulations, and taper gradually from their bases to slender points. No chitinized accessory piece appears to be present. There are apparently nine pairs of caudal papillae, of which seven project more or less laterally into the alae, while two are situated ventrally behind the cloacal aperture. As only one male was available, and in this specimen the spicules were extruded, it is not certain whether any further ventral papillae may have been hidden from view by them. Of the laterally-placed papillae, two relatively small pairs are close to the tail-spike, the most posterior being directed more ventrally, the second more dorsally. The next two pairs are very close together and rather

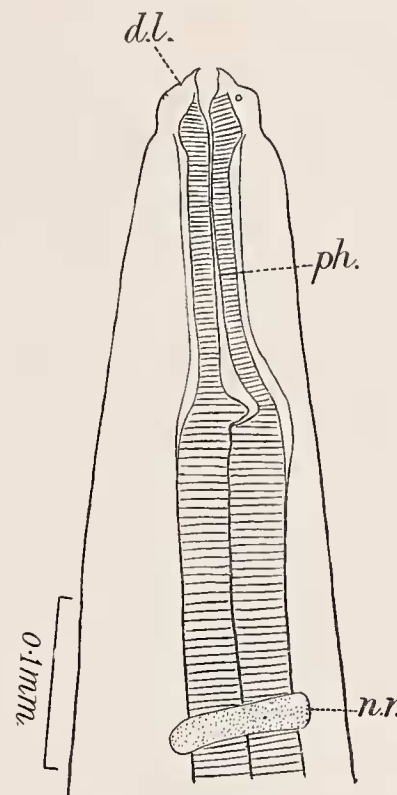


FIG. 31.—*Strongyluris chamaeleonis*. Anterior end of female; lateral view.

*dl.*, dorsal lip; *n.r.*, nerve-ring; *ph.*, pharynx.

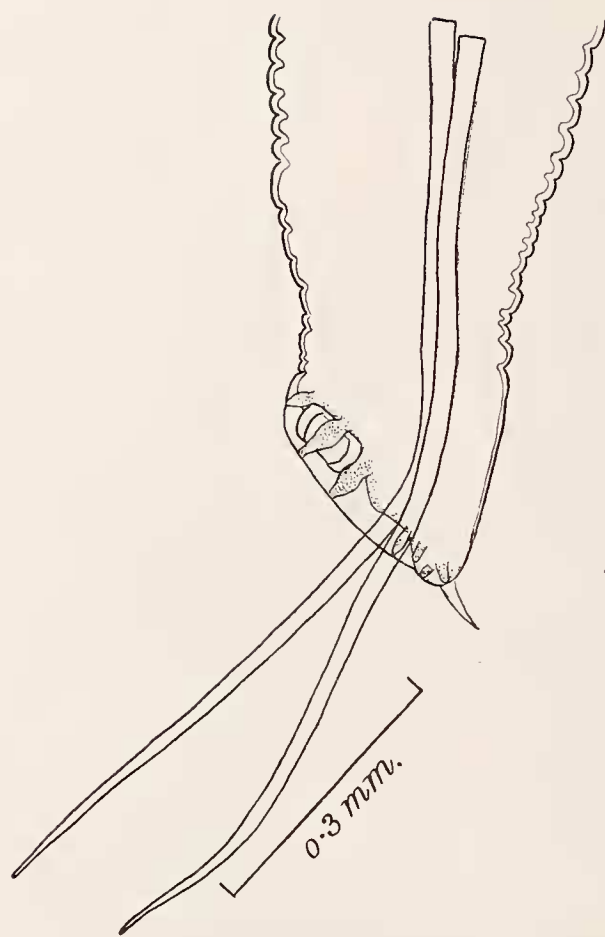


FIG. 32.—*Strongyluris chamaeleonis*. Posterior end of male; lateral view.

mm. When ready for laying the content of the egg is still unsegmented and coarsely granular.

Of the species referred to the genus *Strongyluris*, two, *S. sonsinoi* (v. Linst., 1894) and *S. elegans* (Gendré, 1909), occur in chamaeleons, the former in the same chamaeleon as the present species. *S. sonsinoi*, however, differs widely from our form, and from all others except *S. campanula* (v. Linst., 1899), in the elongate and conical shape of the tail in the male and in the possession of small, sessile, caudal papillae instead of the typical elongate, ray-like papillae. The present species is more closely related to *S. elegans*, but differs from it in its smaller size and the much longer spicules of the male, besides other details; and we are equally unable to identify it with any of the known species parasitic in lizards.

As regards the systematic position of *Strongyluris*, Seurat (1917), in opposition to the view taken by most authors,

slender. The remaining three pairs form a group on either side of the sucker, decreasing in size from behind forwards. The most posterior of these three pairs is very massive. The length of the tail (i.e., from the cloaca to the posterior extremity) is about 0.13 mm., of which the terminal spike measures 0.06 mm.

In the female the short, conical tail measures 0.3 mm. in length, and bears a pair of small papillae at 0.14 mm. from the tip. The vulva is situated at 3.0–3.3 mm. from the posterior end. The vagina is long, slender, and pursues a rather tortuous course, the general direction of which is posterior from the vulva. The branches of the uterus are parallel, running at first posteriorly to within a short distance of the anus, then returning towards the anterior end. The coils of the ovaries are situated in the anterior half of the body. The eggs are oval, with a thick shell, slightly flattened externally and thickened internally at each pole. They measure about  $0.0875 \times 0.055$

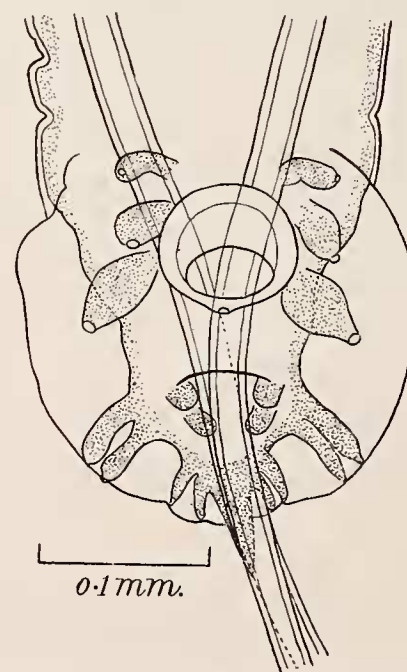


FIG. 33.—*Strongyluris chamaeleonis*. Posterior end of male; ventral view.



regards it as related rather to the Oxyuridae than to the Heterakidae. His contention is based chiefly on the characters of the lateral fields and of the body-muscles. The other points mentioned (presence of lateral alae on the body, absence of caudal alae in the male), are clearly not universal characters of *Strongyluris* as at present constituted. On the other hand, the structure of the preanal sucker, which is exactly similar to that of *Heterakis*, is a character probably quite as important as the lateral fields; while the arrangement of the musculature does not appear in all cases to be a reliable guide to classification. Travassos, in a recent paper (1920 [?]) has suggested placing *Strongyluris* in a new subfamily, Spinicaudinae, of the Heterakidae. Railliet and Henry (1914), regarded it as a subgenus of *Heterakis*. We prefer to treat it as a genus, with close relationships to *Heterakis*, and reserve judgment on the question of including it in a separate subfamily. The following tabular arrangement of the species shows that there are two well-marked groups within the genus as hitherto constituted, these groups being characterized chiefly by the presence or absence of caudal alae in the male.

A. Tail of male without alae.

a. Tail long, straight and tapering. An accessory piece present.

*S. sonsinoi* (v. Linst., 1894).

*S. campanula* (v. Linst., 1899).

b. Tail obliquely truncate ventrally, but with an elongate terminal cone. An accessory piece present.

*S. icosiensis*, Seurat, 1917.

B. Tail of male with bursa-like alae and obliquely truncate.

Accessory piece absent.

*S. brevicaudata*, Müller, 1894.

*S. paronai* (Stossich, 1902).

*S. elegans* (Gendré, 1909).

*S. chamaeleonis*, sp. nov.

*S. ornata* (v. Linst., 1897) and *S. streptoesophageus*, Connal, 1912, are probably synonymous with *S. brevicaudata*.

It seems justifiable to restrict *Strongyluris* to the forms (B) which agree with its genotype, *S. brevicaudata*, in the characters mentioned; while we propose to erect a new genus, **Sonsinia**, to include the non-alate forms, with *S. sonsinoi* as genotype. *S. icosiensis* appears to occupy a somewhat intermediate position, but for the present may be referred to *Sonsinia*.

Genus **Pseudaspidodera**, nov.

**Pseudaspidodera pavonis**, sp. nov.

(Figs. 34-37.)

Hosts: Burmese peafowl (*Pavo muticus*) and "white peafowl" (*Pavo cristatus*).

This is a small worm, the male measuring about 6 mm. in length, the female 7 mm. The greatest thickness is about 0.25 mm. in the male, 0.3 mm. in the female. The cuticular striations, if present, are too fine to measure. The head (fig. 34) is ornamented with "cordons" resembling those of *Aspidodera*, opening in pairs at the interlabial spaces, and consisting of tubular grooves running below the surface of the cuticle, with a narrow external opening along their length. The members of each pair of cordons diverge at once and, after running back for a short distance, turn forward, each on to the outer surface of one of the three lips, where, instead of joining the corresponding member of the next pair, as in *Aspidodera*, it ends separately. The diameter of the head at the posterior limit of the cordons is about 0.1 mm. Narrow



lateral alae run down the body from a little in front of the nerve-ring nearly as far as the tail. The oesophagus is muscular throughout, 1.4–1.48 mm. long in the male, 1.5–1.6 mm. in the female. It is divided a little behind the head into a very short anterior portion, and a long posterior portion which ends in a well-developed pyriform

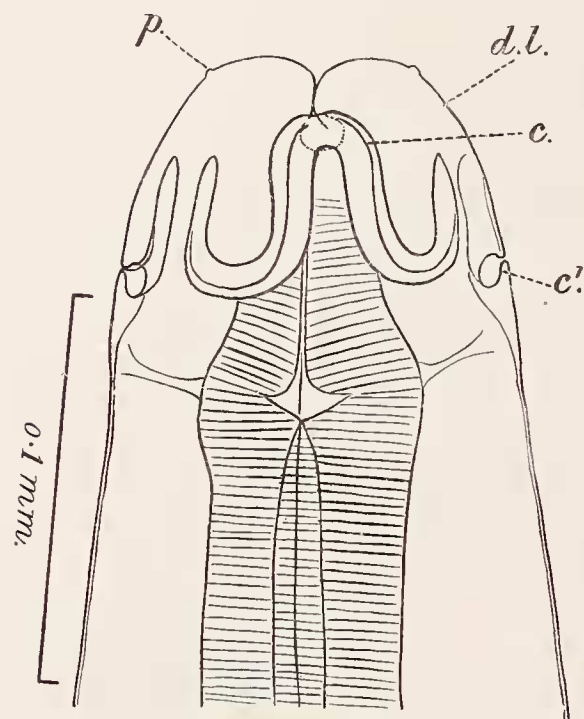


FIG. 34.—*Pseudaspidodera pavonis*. Head of female; lateral view.

c., cordon; c', optical section of same; d.l., dorsal lip; p., papilla.

bulb. At the division of these two portions there appears to be some kind of valvular apparatus. The bulb measures 0.25–0.26 mm. in length and 0.17–0.19 mm. in diameter transversely, and contains the usual valves. The nerve-ring is situated at 0.4–0.46 mm., and the excretory pore at 0.6–0.65 mm., from the anterior extremity.

In the male, the tail (figs. 35, 36) which is 0.38–0.43 mm. long, is provided, for rather less than the anterior half of its length, with wide alar expansions, into which some of the caudal papillae project. The remainder of the tail is simple and slender, ending in a fine, tapering point. There is a circular preanal sucker, 0.12–0.13 mm. in diameter, with well-developed chitinous wall, situated at 0.15–0.17 mm. in front of the cloaca. The greatest diameter (antero-posterior) of the opening of the sucker is about 0.07 mm. The two

spicules are very unequal and dissimilar. The right spicule is slender and simple, measuring 0.78 mm. in length. The left is provided with broad alae at the sides, has a barbed tip, and is only 0.45 mm. long. There is no accessory piece. There are twelve pairs of caudal papillae, the arrangement of which can be understood most readily by reference to the figures. Three pairs, of which the middle pair is more ventrally situated and slightly larger than the others, form a group just in front of the filamentous portion of the tail. The fourth pair is solitary, projecting laterally into the alae. There is an adanal cluster of papillae consisting of four more or less lateral pairs with long stalks, and two small, sessile, ventral pairs, one in front of and one behind the cloaca. Of the four lateral pairs the most posterior is the stoutest, and projects laterally. The next is more ventrally directed. The next is again lateral; while the most anterior of the group projects ventrally. There are two very slender and long-stalked papillae on either side of the sucker.

In the female the tail is long and straight, tapering to a slender point. It measures 1.0–1.02 mm. At about the middle of its length there is a very minute pair of caudal papillae. The vulva is situated behind the middle of the body, at about 3 mm. from the posterior end. It leads into a vagina (fig. 37) which is convoluted in a characteristic manner—running forward at first, as a strongly muscular ovejector, it curls first in a semicircle so as to return towards the body-wall on the ventral side.

Then, taking a turn to the right, and dorsally again, it doubles back upon itself. On reaching a point just behind the level of the vulva the character of the walls changes,

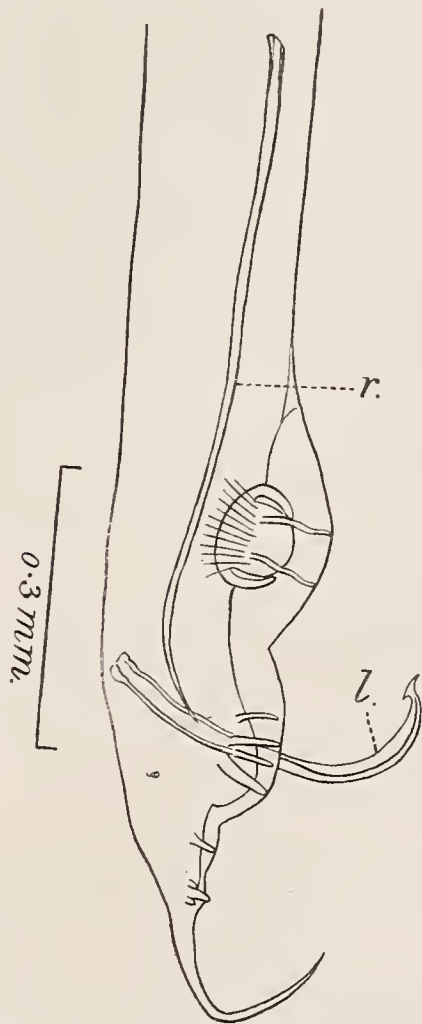


FIG. 35.—*Pseudaspidodera pavonis*.  
Posterior end of male; lateral view.  
*l.*, left spicule; *r.*, right spicule.

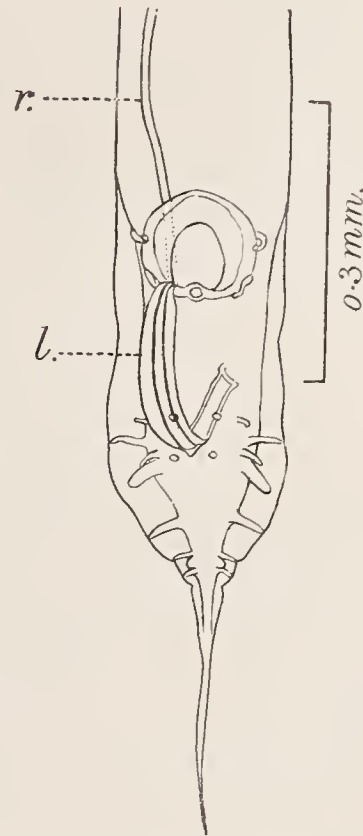


FIG. 36.—*Pseudaspidodera pavonis*.  
Posterior end of male; ventral view.  
*l.*, left spicule (protruded); *r.*,  
right spicule.

the circular coat of muscles being much less strongly developed. The tube runs back from this point quite straight to a distance of about 0.8 mm. behind the vulva. Here it doubles upon itself again, and at about 0.15 mm. behind the vulva gives off the two opposed uteri. As in *Heterakis*, the two oviducts, doubling upon themselves in the anterior and posterior halves of the body respectively, return and cross each other so that the coils of the ovary belonging to the anterior uterus are disposed in the posterior half of the body, and those of the other ovary in the anterior half. The ova are relatively large, of somewhat oblong shape, with a thin

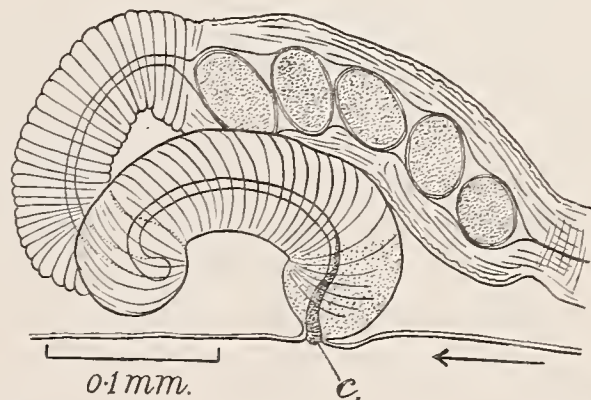


FIG. 37.—*Pseudaspidodera pavonis*. Vulva and  
vagina of female, in lateral view.  
*c.*, plug of cement in vulva. The arrow points in the  
direction of the head.



shell measuring about  $0.07 \times 0.04$  mm., and usually showing a slight internal thickening at one pole. One end of the shell, as seen *in utero*, is occasionally drawn out almost to a point. The content of the egg is unsegmented at the time of laying.

The characters of this form are such that it appears to form a link between the genera *Heterakis* and *Aspidodera*. It has cephalic "cordons" similar to, but rather less highly-developed than, those of *Aspidodera*; while it possesses long, pedunculate caudal papillae in the male, like those of *Heterakis* in shape and arrangement, and unlike the more sessile papillae of *Aspidodera*. The markedly dissimilar spicules and the absence of an accessory piece are also characters of *Heterakis* rather than of *Aspidodera*.

Two species of *Heterakis* have been recorded in peafowl—*H. papillosa* (Bloch) and *H. hamulus*, v. Linst., 1906. The former is, of course, a well-known species and the genotype of *Heterakis*. Although the description of *H. hamulus* is rather brief, it appears sufficient to prevent the identification of the present form with that species.

Subfamily *SUBULURINAE*, Travassos, 1914.

Genus *Subulura*, Molin, 1860.

*Subulura sarasinorum* (Meyer, 1896).

This species occurred in the intestine of a slender loris (*Loris gracilis*)<sup>1</sup> in the Calcutta Zoological Garden.

*Subulura galloperdicis*, sp. nov.

(Fig. 38.)

This species was collected from the intestine of the Red spur-fowl (*Galloperdix spadicea*).

The female measures 11.5 to 12.5 mm. in length and about 0.4 mm. in thickness; the male 9.5 to 10 mm. and 0.3 mm. respectively. The head is small, measuring about 0.08 mm. in diameter. There are narrow cephalic alae which extend to a distance of about 1 mm. from the anterior end. The buccal cavity is 0.06 mm. deep, about 0.023 mm. wide at the anterior end, and 0.031 mm. at the posterior end. There are three triangular teeth at the base of the buccal cavity, two sub-dorsal, and one ventral and median. The height of the teeth is about 0.013 mm. The nerve-ring is situated at 0.27 mm. from the head, whilst the excretory pore opens on the ventral surface at 0.45 mm. from the head. The oesophagus consists of a long muscular portion with the usual prebulbar swelling, and a large bulb containing the grinding apparatus. The anterior portion is 1.5 mm. in length, and the prebulbar swelling 0.14 mm. in thickness. The bulb is roughly spherical and has a diameter of 0.2 mm. The vulva is situated in the anterior half of the body, dividing the latter in the ratio of 3 : 4. There is a short transverse vagina from which large, well-developed ovejectors run anteriorly and posteriorly. The ovaries commence at the anterior and posterior bends of the uteri, and terminate in the vicinity of the vulva. The bend of the anterior genital tube is at about 0.42 mm. from the oesophageal bulb, while that of the posterior is at about 0.22 mm. from the tip of the tail. The ova measure

<sup>1</sup> Now called *Loris lydekkerianus*.



0.065 × 0.035 mm. and contain fully-formed embryos. The anus is situated at 1.1 mm. from the tip of the tail.

The tail of the male (fig. 38) measures 0.21 mm. in length and is drawn out at the tip into a fine point. There are eleven pairs of papillae, four pairs of which are preanal, two adanal, and five postanal. The sucker is situated at about 0.65 mm. in front of the anus, and is spindle-shaped. Of the preanal papillae a latero-ventral pair is situated on the lateral border of the sucker and towards its anterior margin: variation in the position of this pair is not uncommon. The remaining three pairs are placed between the sucker and the anus. The anterior of these is laterally placed at about 0.15 mm. behind the sucker. The next two pairs are ventral, one being about 0.07 mm. behind the preceding pair, and the other just anterior to the adanal

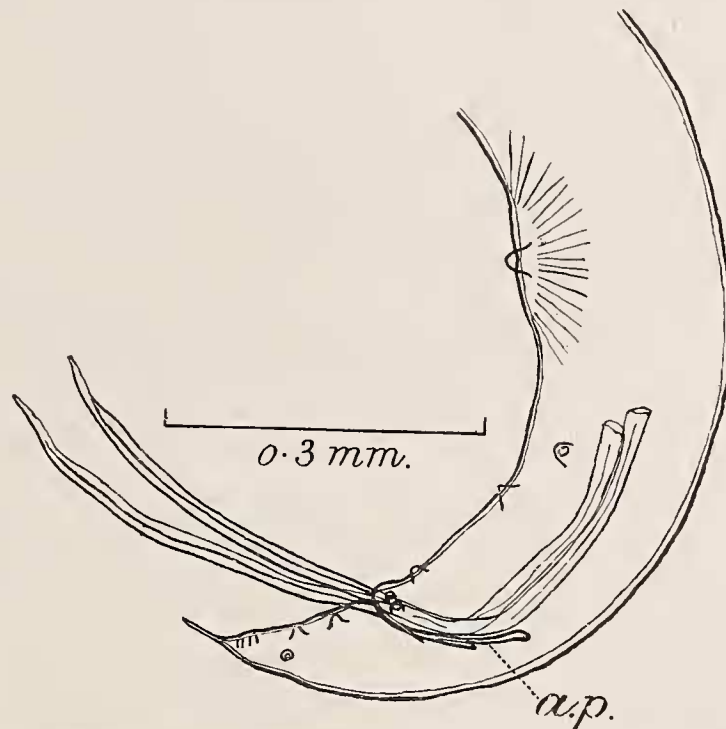


FIG. 38.—*Subulura galloperdicis*. Posterior end of male; lateral view.  
a.p., accessory piece.

papillae. The two pairs of adanal papillae are placed on the anterior border of the cloaca, one lateral to the other. Of the postanal papillae, the third pair is quite lateral, the remaining four pairs ventral. The first and second pairs are small and close to the tip of the tail. The fifth pair is immediately posterior to the anus, and the fourth pair is a little less than half-way between the second and fifth pairs. The third pair, which is lateral, is situated about midway between the anus and the tip of the tail.

The spicules are equal, long and slender. They measure from 0.76 to 0.8 mm. in length, and are tapered to a fine but rounded point. They consist of a cylindrical axis, which measures about 0.011 mm. in diameter, and two alae. Their total width is about 0.02 mm. The edges of the alae are very finely serrated. There is an

accessory piece (fig. 38, a.p.), which is slender and curved. It measures about 0.18 mm. in length and has a spur at about 0.06 mm. from its anterior end.

The male genital tube is much coiled and reaches to within 0.7 mm. of the oesophageal bulb.

The number and disposition of the caudal papillae in the male, the length of the spicules and accessory piece and the position of the vulva in the female are salient characters which serve to distinguish *Subulura galloperdicis* from the other members of this genus occurring in galliform birds.

There are five members of this group which possess eleven pairs of papillae, viz., *S. curvata* (v. Linst., 1883), *S. strongylina* (Rud. 1819), *S. olympioi*, Barreto, 1919,<sup>1</sup> *S. halli*, Barreto, 1919<sup>1</sup> and *S. seurati*, Barreto, 1919.<sup>1</sup>

*S. curvata* has unequal spicules measuring 1.2 and 0.9 mm. respectively, and the papillae are made up as follows:—2 pairs preanal, 2 adanal, and 7 postanal. *S. strongylina* possesses a chitinous tail appendage. The papillae consist of 3 preanal, 2 adanal, and 6 postanal pairs. The spicules measure 0.899 mm. in length. *S. olympioi* has 3 pairs of preanal, two pairs of adanal and six pairs of postanal papillae. *S. halli* has five pairs of preanal papillae; and the spicules measure 1.5 mm. in length. In *S. seurati* the spicules are unequal and there are 5 pairs of preanal papillae, while the vulva is situated at the junction of the anterior and middle thirds of the body.

### **Subulura, sp.**

The collection contains two females of a species of *Subulura* taken from the Button-Quail (*Turnix*, sp.) One of the specimens is badly damaged. The complete specimen measures 14 mm. in length and 0.41 mm. in thickness. The head measures about 0.08 mm. in diameter. The buccal capsule is 0.035 mm. deep and 0.02 mm. wide. The usual teeth are present.

Narrow cephalic alae extend as far as the beginning of the prebulbar oesophageal swelling. The total length of the oesophagus is 1.1 mm., while the diameter of the bulb, which is roughly spherical, is 0.15 mm. The nerve-ring encircles the oesophagus at 0.1 mm. from the anterior end. The excretory pore opens at 0.4 mm. from the head in the median ventral line. The anus is situated at 0.32 mm. from the tip of the tail, which is acutely pointed. The vulva is situated at 6.1 mm. from the anterior end. The posteriorly-directed vagina is just discernible. For the rest the body of the worm is completely filled with eggs, reaching anteriorly up to within 0.07 mm. of the anterior end, and posteriorly to within 0.1 mm. of the tip of the tail. The eggs are in various stages of development, some containing fully-formed embryos. They are thin-shelled and measure 0.085 × 0.056 mm.

It is not possible to assign these specimens to a definite species.

Family OXYURIDAE, Cobbold, 1864.

Genus **Oxyuris**, Rud., 1803.

**Oxyuris anthropopithecii**, Geddoelst, 1916 (?).

Host: Black-headed lemur \* (probably *Lemur brunneus*).

<sup>1</sup> In Barreto's (1919) monograph of the subfamily Subulurinae, these species are given as "*S. olympioi*, Barreto, 1918," "*S. halli*, Barreto, 1917" and "*S. seurati*, Barreto, 1917." The names, however, do not appear to have been published previously to 1919, although the work was in preparation in 1917.

No *Oxyuris* appears to have been recorded in true lemurs, though two forms, *O. corollatus*, Schneider, 1866 and *O. coronata*, v. Linst., 1903, are recorded in *Galeopithecus*. It is impossible to identify the present material with either of these, both of which have characteristic spinous structures on or near the head. Of the forms found in apes and monkeys, the nearest appears to be *O. anthropopithecii*, from the chimpanzee. Both Gedoelst's material and our own has unfortunately consisted only of females, so that the characters available for determination are scanty, and we have been compelled to rely chiefly on measurements. While, therefore, we find a fairly close agreement between our material and Gedoelst's (1916) description, the determination, especially in view of the difference of hosts, can only be regarded as tentative.

***Oxyuris compar*, Leidy, 1856 (?).**

A single female, from the intestine of a domestic cat in Calcutta, is doubtfully referred to this little-known and apparently rare species.

Genus ***Atractis***, Duj., 1845.

***Atractis dactylura*** (Rud., 1819).

Examples of this species, all young females, occurred in association with *Zanclophorus kempi* (see p. 312) in the intestine of *Testudo elongata* at Baradighi, Jalpaiguri, Bengal.

***Atractis opeatura*, Leidy, 1891.**

Syn. *A. cruciata*, v. Linst., 1902.

This form occurred in large numbers in the intestine of an iguana\* (species not mentioned) in the Zoological Garden, Calcutta. Unfortunately, the specimens are in rather poor condition and not quite mature. They show no important differences from the descriptions furnished by von Linstow ((1901 *a*) and (1902)) and by Railliet and Henry (1912), except that there is an additional pair of small caudal papillae, adanal in position, in the male.

*Note*.—Travassos (1920 [?]) proposes a family Atractidae, which he considers to belong to the superfamily Rhabdiasoidea (= Angiostomoidea). The included genera are *Atractis*, *Ozolaimus*, *Rondonia*, *Labiduris*, *Crossocephalus*, *Macracis*, *Cobboldina* and *Cyrtosomum*. These are, for the most part, little-known forms, and in the present unsatisfactory state of our knowledge of the Oxyuridae as a family, and in the absence of a definition of the family Atractidae, we prefer to adopt a conservative attitude as to the position of *Atractis*. The whole question of the relationships of the Angiostomoidea (or Rhabdiasoidea) is much involved at present; but it may be remarked, in passing, that the definition of the Angiostomoidea is based mainly on the fact that its species have two heterogenetic generations, and the parasitic phase is without males. This is not known to be the case with the forms included in Travassos' proposed family, though in *Atractis dactylura* an alternation of generations of a different kind is said to occur (Macé, 1887). Here the females of the parasitic phase are viviparous, and the generation to which they give rise is said to consist entirely of oviparous females.

Family KATHLANIDAE, Travassos, 1918.

Genus ***Falcaustra***, Lane, 1915.

The collection includes examples of four species of this genus, all of which appear to be new. The following known species have been assigned to the genus up to the present:



*F. falcata* (v. Linst., 1906), from *Geoemyda trijuga*,  
*F. lambdiensis*, Seurat, 1918, from *Clemmys leprosa*,  
*F. siamensis*, Baylis, 1920, from *Hieremys annandalei*;

while we may also refer to it

*F. [Oxysoma] kachugae* (Stewart, 1914), from *Kachuga lineata*.

The hosts of all these species are tortoises. Of the new species to be described, two are from tortoises and two from a fish. Some of them show considerable divergence from the typical characters, and will necessitate some modification of the generic diagnosis. We do not, however, feel justified in splitting up the genus at present, as it would be hard to find a clear and satisfactory dividing-line between the typical and the atypical species.

Taking first the forms that depart least from the characters of the genotype, we have the following:—

***Falcaustra testudinis*, sp. nov.**

(Fig. 39.)

Host: *Testudo elongata*. Locality: Assam (Tura, foot of Garo Hills).

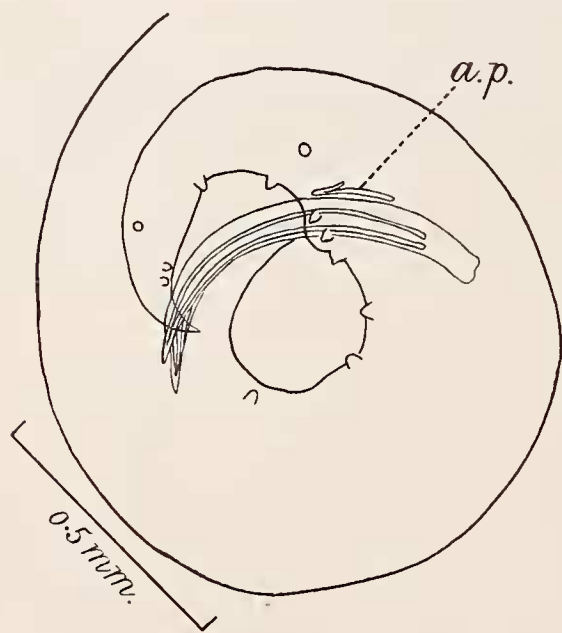
This is the smallest species hitherto met with. The male measures 10.2–10.4 mm. in length and 0.6 mm. in thickness; the female 9.2–11.5 mm. and 0.6–0.75 mm. respectively. The diameter of the head is 0.15–0.16 mm. This is followed by a slightly narrower neck. The buccal cavity measures about 0.05 mm. in length and

0.03 mm. in diameter. The distinct anterior division of the oesophagus, to which we shall hereafter refer as the “pharynx,” is 0.13–0.14 mm. long. The entire oesophagus, from the extremity of the head to the back of the bulb, measures 1.7–2.1 mm. The bulb consists of two swellings separated by a narrow neck; its length is 0.4–0.45 mm. and the diameter of the larger (posterior) swelling 0.26–0.27 mm. The prominent cervical papillae are situated at 1.03–1.1 mm., the nerve-ring at 0.44–0.45 mm., and the excretory pore at 1.22–1.26 mm., from the anterior end.

In the male the tail is 0.81 mm. long, and there is no preanal sucker-like organ.

FIG. 39.—*Falcaustra testudinis*.—Posterior end of male; lateral view.

a.p., accessory piece.



The caudal papillae (fig. 39) consist of

the typical eleven pairs and one unpaired preanal papilla. Nos. 1 and 2 are close together, ventral; No. 3 lateral; No. 4 isolated, ventral; No. 5 ventral; No. 6 lateral, at about the same level as No. 5; Nos. 7 and 8 at the sides of the cloaca and close together. The spicules measure 0.8 mm. in length and 0.07 mm. in greatest width. The chitinized portion of the accessory piece is 0.15–0.17 mm. long.

In the female the tail is about 1 mm. long, and the caudal papillae are at 0.5 mm. from the tip. The vulva is situated at 3.9–4.7 mm. from the posterior end. The vagina is long, running forward for a distance of 2.3 mm. before giving off the uterine branches. The eggs measure  $0.125-0.137 \times 0.075-0.087$  mm.

***Falcaustra barbi*, sp. nov.**

(Figs. 40, 41.)

Host: Mahseer (*Barbus tor*). Locality: Torsa River, Falakata, Eastern Bengal.

This species measures 15.2–16.5 mm.  $\times$  0.65–0.7 mm. in the male; 15.5–19.6 mm.  $\times$  0.65–1.0 mm. in the female. The cuticular striations, if present, are excessively fine. The almost globular head has a diameter of 0.2–0.22 mm., and is followed by a distinct neck. The buccal cavity measures about 0.07 mm. in length, the pharynx 0.1 mm. The distance from the anterior end to the end of the oesophagus, including the bulb, is 2.5–2.8 mm. The anterior swelling of the bulb is oval in shape and sharply constricted off from both the preceding portion of the oesophagus and the rest of the bulb. The dimensions of the bulb are 0.5–0.59 mm. in length and 0.34–

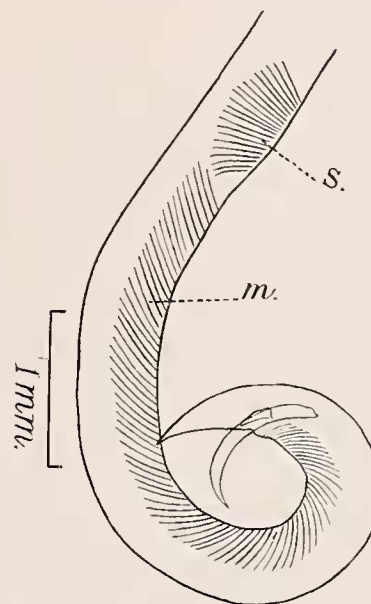


FIG. 40.—*Falcaustra barbi*. Posterior end of male; lateral view.

*m.*, caudal muscles; *s.*, sucker-like organ.

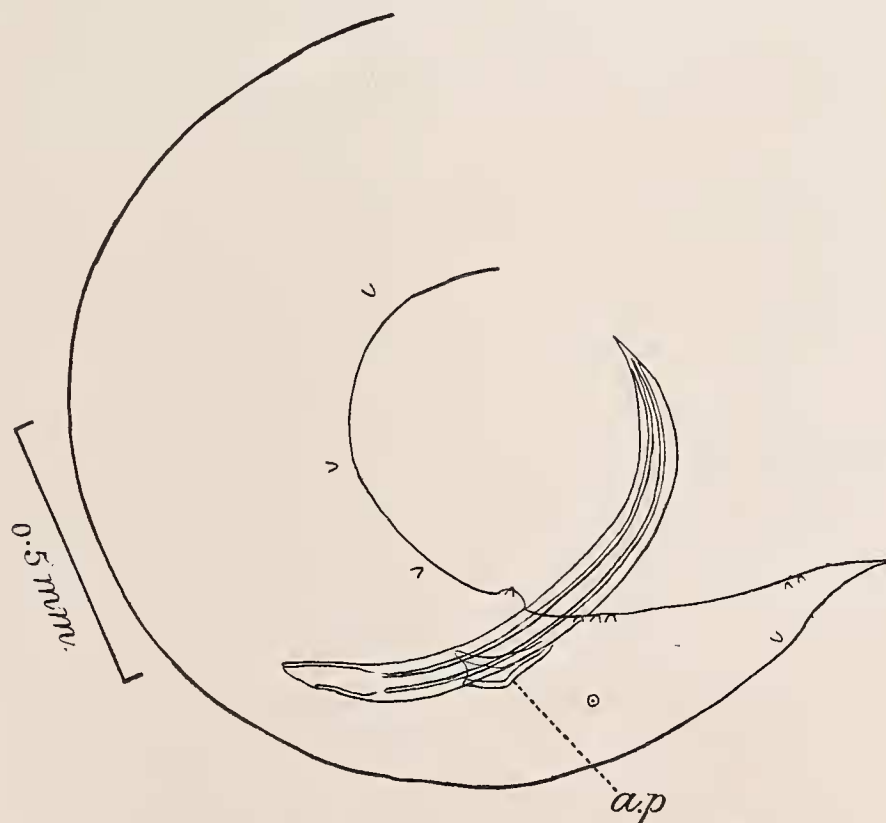


FIG. 41.—*Falcaustra barbi*. Tail of male; lateral view.  
*a.p.*, accessory piece.

0.37 mm. in diameter. The small, but prominent, cervical papillae are situated at 1.2–1.4 mm., the nerve-ring at 0.4–0.5 mm., and the excretory pore at 1.55–1.9 mm., from the anterior end.

The tail of the male is about 0.6 mm. long. There is a single preanal, sucker-like, fan-shaped aggregation of muscles, situated in front of the long series of oblique caudal muscles (fig. 40). The caudal papillae (fig. 41) are very small and inconspicuous. There are ten pairs and an unpaired preanal papilla. Of the postanal papillae Nos. 1 and 2 are close together and ventral; No. 3 lateral. There are three more pairs close together and ventral, and one lateral, just behind the cloaca. The spicules are 1.13 mm. long, and 0.1 mm. wide dorso-ventrally at the widest part, which is near the root. The accessory piece is well-chitinized, and measures 0.2 mm. in length.

The tail of the female is 0.65–0.8 mm. long, and carries a pair of inconspicuous papillae at 0.35 mm. from the tip. The vulva is situated at 6.25–7.3 mm. from the posterior end. The vagina is short (about 1 mm.) and nearly straight. The eggs are roundish oval, and measure about 0.075 × 0.05 mm.

The intestine of every specimen examined contained large numbers of diatoms.

### *Falcaustra leptcephala*, sp. nov.

(Fig. 42.)

Host: Mahseer (*Barbus tor*). Locality: Torsa River, Falakata, Eastern Bengal.

This species occurred together with the preceding, in large numbers, in the same fish. It is easily distinguished from *F. barbi* by its very narrow head and the absence of a neck. It is a large, stout form, especially as regards the females. These appear an opaque white in spirit, owing to the large numbers of eggs in the uterus. The males, in spirit, remain semi-transparent. In both sexes the intestine shows through the body-wall as a blackish line, and this may be partly due to the fact that its contents, as in the case of *F. barbi*, consist very largely of diatoms.

The male measures up to 19 mm. in length and 1.3 mm. in thickness; the female up to 27 mm. and 1.4–1.8 mm. respectively. The cuticular striations are about 0.002 mm. apart. The diame-

FIG. 42.—*Falcaustra leptcephala*. Tail of male; lateral view.

ter of the head is 0.1–0.12 mm. The buccal cavity is about 0.05–0.06 mm. long, the pharynx 0.14–0.17 mm. The whole oesophagus, from the head end to the back of the bulb, measures up to 3.5 mm. The bulb is flask-shaped, having no sharp



constriction between the two swellings. Its length is 0.6–0.67 mm., and the diameter of the posterior swelling 0.45–0.47 mm. The prominent, almost bristle-like, cervical papillae are situated at 1.3–1.4 mm., the nerve-ring at 0.45–0.5 mm., and the excretory pore at 2.0–2.15 mm., from the anterior end.

The tail of the male (fig. 42) measures 0.7–0.85 mm. in length. There is no pre-anal sucker-like organ. The number and arrangement of the papillae are the same as in the preceding species (*F. barbi*)—there being ten pairs and a median preanal papilla. The spicules are about 1 mm. long and 0.09 mm. wide. There appears to be no chitinized accessory piece.

In the female the tail is 1.1–1.3 mm. long. The caudal papillae are very inconspicuous, and are situated at 0.6 mm. from the tip. The vulva is at about 11 mm. from the posterior end. The vagina is narrow, and apparently short, but its course is difficult to trace owing to the dense masses of ova in the uterus. It runs forward and dorsally from the vulva, keeping close to the body-wall. The branches of the uterus are wide, nearly filling the body-cavity. The ova are very much more numerous and considerably smaller than in most of the other species, and of a much more spherical shape. They measure  $0.075 \times 0.055$  mm., and their contents appear to be unsegmented at the time of laying.

***Falcaustra stewarti*, sp. nov.**

(Figs. 43, 44.)

Hosts and localities:

*Kachuga smithii*; Ferozpore, Punjab.

*Hardella thurgi*; Siripur, Saran, Bihar.

This is a species of moderate size, differing from the typical forms in having a larger number of caudal papillae in the male, and in other features. In the material from *Kachuga smithii*, which we take as typical, the length of the male is 17–19.8 mm., that of the female 19–22.6 mm. The greatest thickness is 0.6–0.7 mm. in the male; 0.65–0.75 mm. in the female. The cuticular striation is exceedingly fine. The head has a diameter of 0.19–0.21 mm., and is followed immediately by a slightly narrower neck. The buccal cavity is very shallow, measuring only 0.06 mm. in length. A distinct pharynx is present, 0.09 mm. long. The total length of the oesophagus is 2.1–2.5 mm. The bulb has no marked constriction, and measures 0.5–0.55 mm. in length and 0.3–0.32 mm. in diameter. The small, but very prominent, cervical papillae are at 1.3–1.37 mm., the nerve-ring at 0.5–0.6

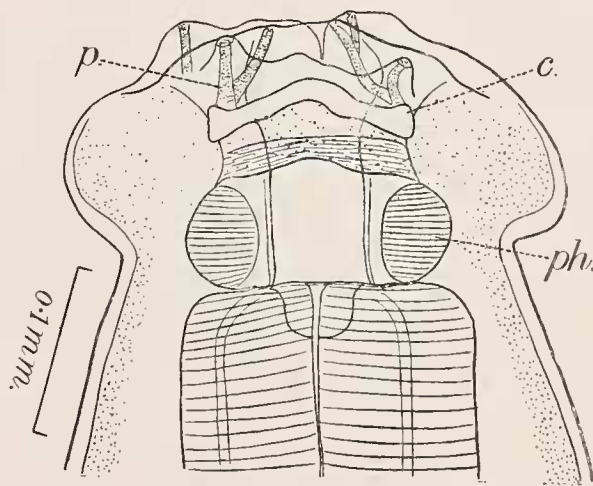


FIG. 43.—*Falcaustra stewarti*. Head of female from *Hardella thurgi*; dorsal view.

c., cuticular ring; p., forked pulp of papillae; ph., pharynx.

mm., and the excretory pore at 1.6–1.65 mm. (male), or 1.75–1.85 mm. (female), from the anterior end.

The tail of the male (fig. 44) is 1.4–1.7 mm. long, and tapers to a slender point. There is no preanal sucker-like organ, but the oblique caudal muscles are well-developed. There are 16–18 pairs of caudal papillae and one median, unpaired papilla, the latter and three pairs being, as usual, preanal. Of the postanal papillae two pairs are lateral, the rest ventral. Occasionally one or two of the anterior ventral pairs become adanal in position. The members of the more posterior pairs sometimes become displaced anteriorly or posteriorly, so as to disturb the symmetry of the paired arrangement. The spicules are short (0.5 mm.) and have a maximum width of 0.09 mm. A vaguely-defined mass of imperfectly chitinized tissue represents the accessory piece, and a fan-shaped bundle of muscles extends from it to the dorsal body-wall.

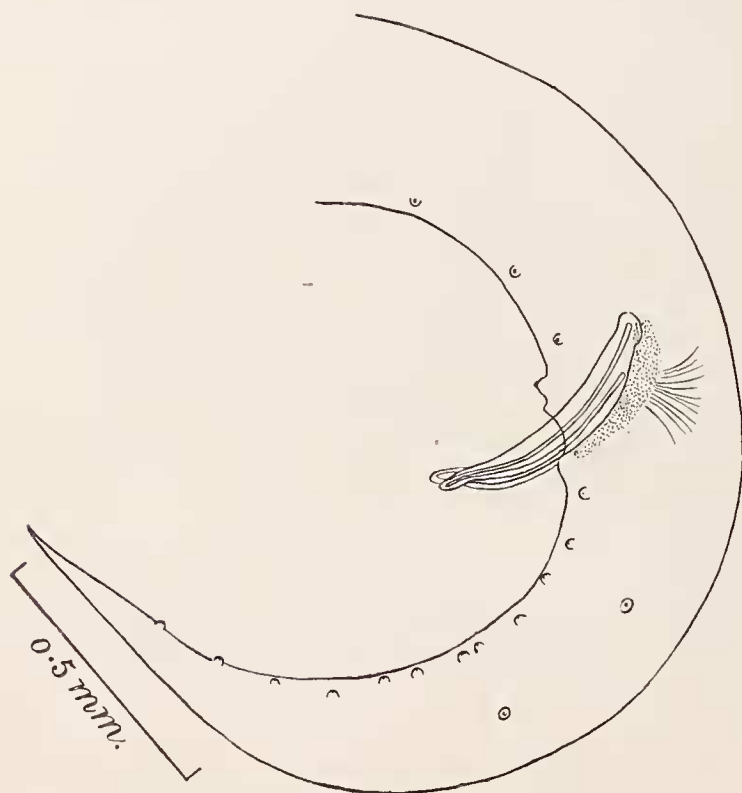


FIG. 44.—*Falcaustra stewarti*. Tail of male; lateral view.

The tail of the female is long (2.25–2.6 mm.), straight and tapering, and ends in a fine point. The caudal papillae are situated at about 1.6 mm. from the tip. The vulva opens at 7.75–10.3 mm. from the posterior end. The vagina is about 1.5 mm. long. The ova measure about 0.15 × 0.105 mm., have a shell 5 $\mu$  thick,

and contain an embryo curled upon itself into a U-shape when ready for laying.

The material from *Hardella thurgi* so closely resembles that from *Kachuga* in almost all respects that we do not feel justified in erecting another species for it. There are, however, certain differences, of which the most conspicuous are the greater relative and absolute width of the head and the much coarser striation of the cuticle. The striae in the *Hardella* material are about 10 $\mu$  apart, whereas in the *Kachuga* material they are so fine that accurate measurement is scarcely possible. Apart from these points the *Hardella* material is slightly larger in almost all dimensions than that from *Kachuga*, and has a stouter general appearance. The measurements may be most conveniently given in tabular form, for comparison with those of the *Kachuga* material:—

					♂ mm.	♀ mm.
Length	..	..	..	..	18.6–20.4	20.2–22.1
Thickness (max.)	..	..	..	..	0.8–0.9	0.8–1.05
Diameter of head	..	..	..	..	0.28–0.3	0.3–0.35
Length of tail	..	..	..	..	1.8–1.9	2.5–2.7



		♂	♀
		mm.	mm.
Distance from ant. end to end of oesoph. (incl. bulb)	..	2.6-2.8	2.7-2.8
,,           ,, nerve-ring	..	0.56	0.6
,,           ,, excretory pore	..	1.9	2.0
Length of pharynx	..	0.1	0.1
Oesophageal bulb, length	..	0.55-0.58	0.6
,,           ,, greatest diameter	..	0.35	0.4
Spicules, length	..	0.54-0.56	....
Vulva, distance from posterior end	..	....	8.5-8.8
Caudal papillae, ♀, distance from tip of tail	..	....	2.0
Ova, measurements	..	....	0.15 × 0.0875

*Falcaustra kachugae*, according to Stewart's (1914) description, seems to differ notably from *F. stewarti* in its much smaller dimensions; but as the type-material consisted only of a single female, which may not have been mature, the question of identity must be left open.

In view of the several new species just described, it is necessary to revise our conception of the generic diagnosis of *Falcaustra*. Diagnoses have been attempted by Seurat (1918) and by Baylis (1920 *b*), but both require some alteration. The following is an attempt at a fresh generic characterization.

### **Falcaustra**, Lane, 1915.

Ascaroidea: Kathlanidae:<sup>1</sup> Meromyarian. Body usually stout, tapering at each end. Lateral fields wide. No lateral alae. Mouth with three lips, each bearing two outer and two inner papillae; the pulp of each outer papilla sends a branch to one of the inner papillae, and is thus Y-shaped. Buccal cavity short, surrounded by a continuous ring<sup>2</sup> of thickened cuticle. Muscular oesophagus divided into a short anterior portion, or pharynx, and a long posterior portion, the latter ending in a well-marked bulb which is constricted in the middle so as to take the form of two more or less distinct swellings connected by a narrower neck. The oesophagus, with the exception of the bulb, is usually considerably coloured with a reddish-brown pigment, and there are generally special masses of this pigment in the region of the nerve-ring. Excretory pore towards the posterior end of the oesophagus. Tail in both sexes tapering and pointed. Caudal end of male without alae, and provided with ten or more pairs of papillae (of which three pairs are constantly preanal), and an unpaired, median precloacal papilla. Of the postanal papillae two pairs are constantly lateral. Preanal caudal muscles well-developed, sometimes aggregated into one or several fan-shaped groups to form sucker-like organs. Spicules equal, sickle-shaped, broad dorso-ventrally and compressed laterally, each having the appearance of a spicule within a spicule. An accessory piece usually present, sometimes imperfectly chitinized or even absent. Vulva towards posterior third of body. Vagina runs forward and gives off two opposed uteri, each of which doubles upon itself in a number of longitudinally-disposed U-shaped loops in the anterior or posterior region of the body respectively. Each ovary forms a loop in the

<sup>1</sup> Travassos (1918) established this family to include the genera *Kathlania*, *Tonaudia*, *Falcaustra* and *Florencioia*. It is the family Pseudo-heterakidae, Travassos, 1917, renamed and reconstituted. No family diagnosis however, seems to have been attempted. In our opinion the genus *Cruzia*, Travassos, 1917, should also be included in the family, and not referred to a separate family Cruzidae, as Travassos has proposed. We have also to add a further new genus, closely allied to *Falcaustra* (see below, p. 310).

<sup>2</sup> Seurat (1918) in his diagnosis of the genus, speaks of the buccal cavity being "encadrée dans sa région moyenne par trois plaques chitineuses." If such a structure exists in *F. lambdiensis*, the form studied by him, it would appear to approach our genus *Zanclophorus* (see below, p. 310), though the rest of its characters seem to be those of *Falcaustra*.



anterior region of the body, that belonging to the anterior uterus being confined to this region, while the posterior ovary eventually runs back to terminate in the hinder region. Ova usually large and thick-shelled, of oval shape, and laid at different stages of development in different species.

*Hab.* Intestine of Chelonia and freshwater fishes.

Genotype : *F. falcata* (v. Linst., 1906), from *Geoemyda trijuga*.

Owing to the great similarity in structure between most of the species of *Falcaustra*, specific determination depends very largely upon measurements. The following admittedly artificial attempt at a key to the species is based almost entirely on male characters, and therefore omits one species (*F. kachugae*) of which only the female is known.

A. Inhabiting tortoises.

I. Several preanal sucker-like organs present in male.

a. Pairs of caudal papillae 10; spicules about 0.9 mm.

long .. .. . *siamensis*.

b. Pairs of caudal papillae 11; spicules about 1.3 mm.

long .. .. . *lamaldiensis*.

II. Preanal sucker-like organs absent.

a. Pairs of caudal papillae 10 .. .. . *falcata*.

b. Pairs of caudal papillae 11 .. .. . *testudinis*.

c. Pairs of caudal papillae 16-18 .. .. . *stewarti*.

B. Inhabiting fishes.

I. A preanal sucker-like organ present in male. Head wider

than neck .. .. . *barbi*.

II. Preanal sucker-like organ absent. Head narrower than

neck .. .. . *leptocephala*.

Genus *Zanclophorus*, nov.

The collection contains two interesting species which are clearly very closely related to *Falcaustra*, but differ from it, in our opinion, sufficiently to necessitate the formation of a new genus, which may be defined as follows :—

Kathlanidae : closely resembling *Falcaustra* in general appearance. Head somewhat narrower than neck, surrounded by a slight cuticular collar at the base. Three large, flattened lips, each carrying a pair of rather prominent papillae, and bordered internally by cuticular fringes. A long and wide buccal cavity present, with a cuticular lining. In place of the continuous cuticular ring which surrounds the buccal cavity in *Falcaustra*, there are three separate cuticular supports, in the form of double horse-shoes, at the corners of the mouth. There is no distinct pharynx, but the structure of the oesophagus is otherwise the same as in *Falcaustra*, and it is coloured in the same way with reddish pigment, of which there is a special mass in the neighbourhood of the nerve-ring. Bulb pear-shaped, with narrow middle region. Cervical papillae small and sessile, some distance behind the nerve-ring. Excretory pore towards hinder end of oesophagus. Caudal end of male without alae, but with a single, well-developed, muscular, preanal sucker (not a mere fan-like arrangement of muscles). Spicules similar to those of *Falcaustra*, but relatively much longer. A large, but not completely chitinized, accessory piece present. Female genital organs as in *Falcaustra*.

*Hab.* Stomach and intestine of Chelonia.

Genotype : *Z. annandalei*, sp. nov., from *Testudo travancorica*.

***Zanclophorus annandalei*, sp. nov.**

(Figs. 45-48.)

Host: *Testudo travancorica*. Position: stomach. Locality: Cochin State Forests, Western Ghats.

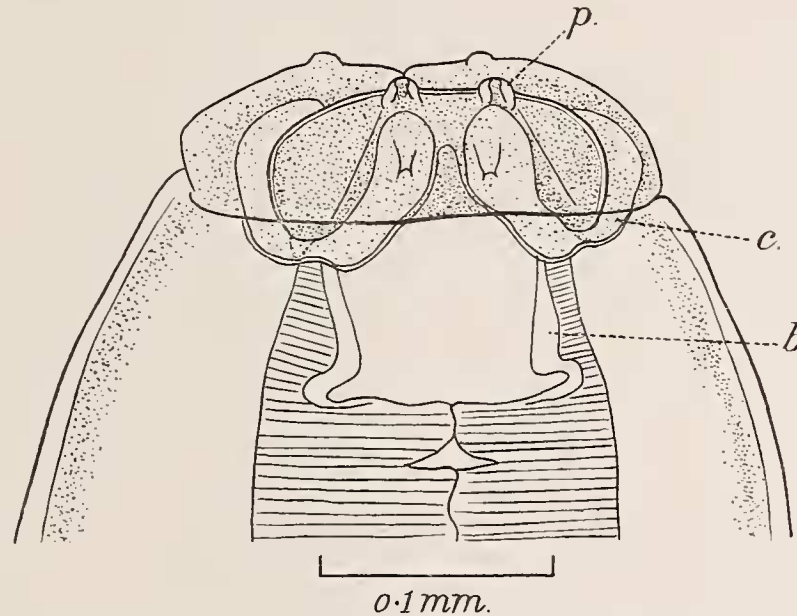


FIG. 45.—*Zanclophorus annandalei*. Head of female; dorsal view.

*b.*, lining of buccal cavity; *c.*, one of the three cuticular supports; *p.*, papilla.

The male measures 15.5-15.9 mm. in length, the female 15.0-17.4 mm. The maximum thickness is 0.85-1.1 mm. The cuticular striations are about  $2\ \mu$  apart. The head (figs. 45, 46) has a diameter of 0.2-0.23 mm. The buccal cavity measures 0.14-0.15 mm. in length and 0.09 mm. in greatest diameter. The distance from the anterior end to the end of the oesophagus, including the bulb, is 2.6-2.85 mm. The bulb measures 0.6-0.65 mm. in length and 0.4-0.44 mm. in diameter. The cervical papillae are at 1.5-1.74 mm., the nerve-ring at 0.55-0.6 mm., and the excretory pore at 2.2 mm., from the anterior end.

In the male, the tail (figs. 47, 48) is 0.45-0.5 mm. long. The sucker is situated at about 1.5 mm. in front of the cloaca. The caudal papillae are arranged in ten pairs and one median precloacal papilla. Of these, four pairs are postanal (2 ventral and 2 lateral), the rest preanal, consisting of three pairs close together near the

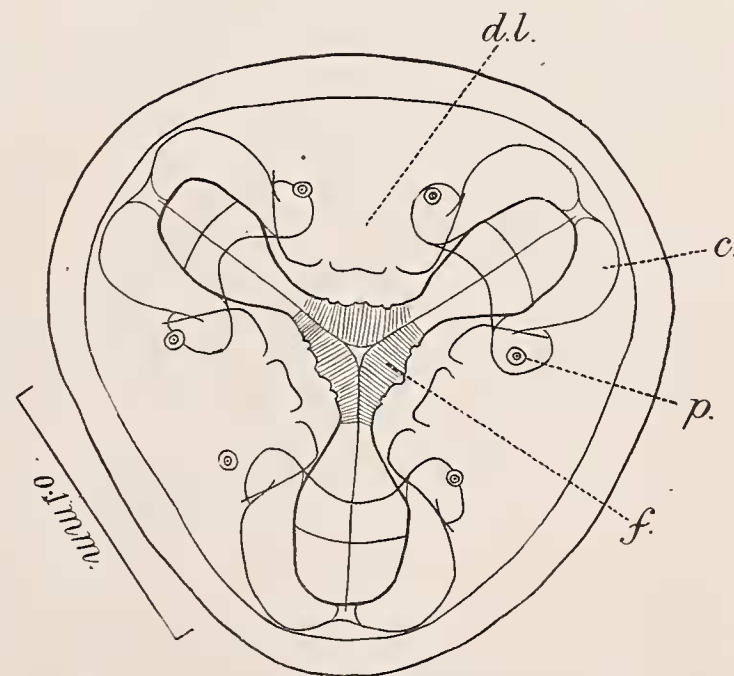


FIG. 46.—*Zanclophorus annandalei*. Lips, viewed en face.

*c.*, one of the three cuticular supports; *d.l.*, dorsal lip; *f.*, cuticular fringe of lip; *p.*, papilla.

cloaca, and three more pairs, more widely separated, between these and the sucker. The spicules measure 2.2–2.3 mm. in length, and have a maximum width of 0.058 mm. The large accessory piece (figs. 47, 48, *a.p.*), which is only partially chitinized, is deeply cleft in front.

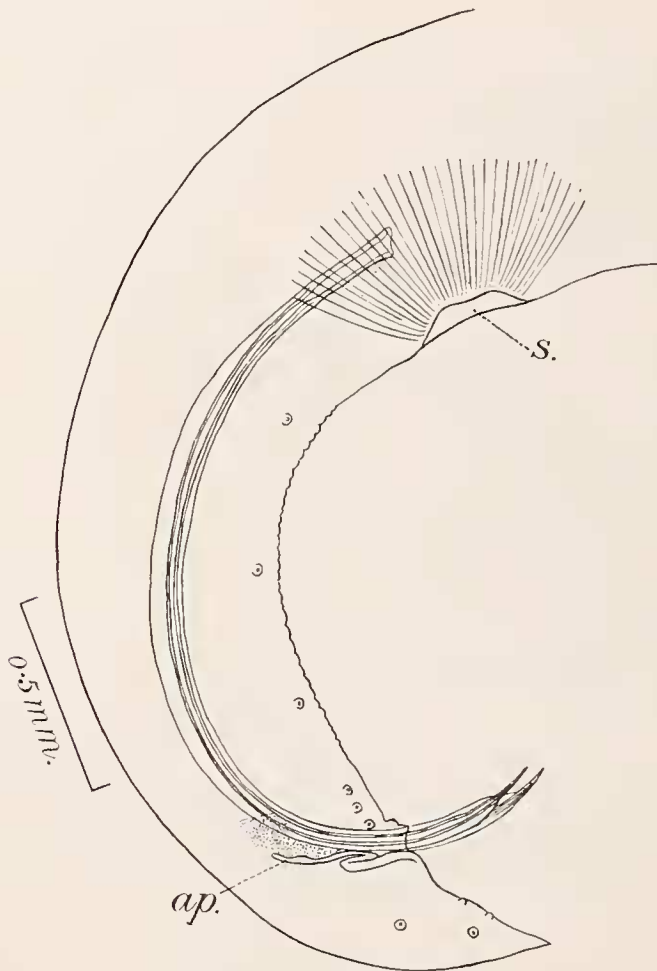


FIG. 47.—*Zanclophorus annandalei*. Posterior end of male; lateral view.

*a.p.*, accessory piece; *s.*, sucker.

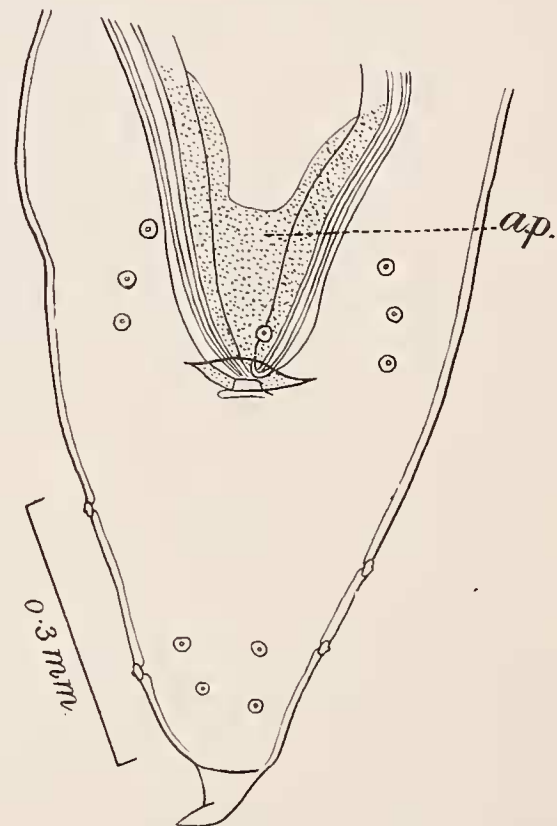


FIG. 48.—*Zanclophorus annandalei*. Tail of male; ventral view.

*a.p.*, accessory piece.

In the female, the tail measures 0.7–0.75 mm. in length. The caudal papillae were not seen. The vulva opens at 5.0–5.5 mm. from the posterior end. The vagina runs forward for about 2 mm. before giving off the two directly opposed uteri. Very few of the females contained ova, and it may be doubted whether those seen were quite fully-formed. They measured about  $0.125 \times 0.075$  mm.

### *Zanclophorus kempi*, sp. nov.

(Fig. 49.)

Host: *Testudo elongata*. Position: intestine. Localities: Baradighi, Jalpaiguri, Bengal; and near Tura, foot of Garo Hills, Assam.

The length of the male is 10.9–12.8 mm., and its thickness 1.0–1.1 mm. The corresponding measurements for the female are 13.4–15.8 mm. and 1.2–1.4 mm. The cuticular striations are exceedingly fine. The diameter of the head is 0.22–0.24 mm. The buccal cavity measures 0.13 mm. in length and 0.09–0.1 mm. in greatest



diameter. The distance from the head end to the posterior end of the oesophageal bulb is 2.3–2.5 mm. The bulb measures 0.45–0.6 mm. in length and 0.4–0.48 mm. in diameter. The cervical papillae are at 1.5–1.6 mm., the nerve-ring at 0.52–0.58 mm., and the excretory pore at 1.7–1.95 mm., from the anterior end.

The tail of the male (fig. 49) is 0.45–0.55 mm. long. The sucker, which is deep and strongly muscular, is situated at about 1.1 mm. in front of the cloaca. There are nine pairs of caudal papillae and the usual median precloacal papilla. The arrangement is the same as in *Z. annandalei*, except that one of the three pairs immediately in front of the cloaca is absent. The two pairs present in this position are small, and the three more anterior pairs much larger. The spicules are relatively large, measuring 2.9 mm. in length and 0.1 mm. in width. The accessory piece is similar to that of *Z. annandalei*.

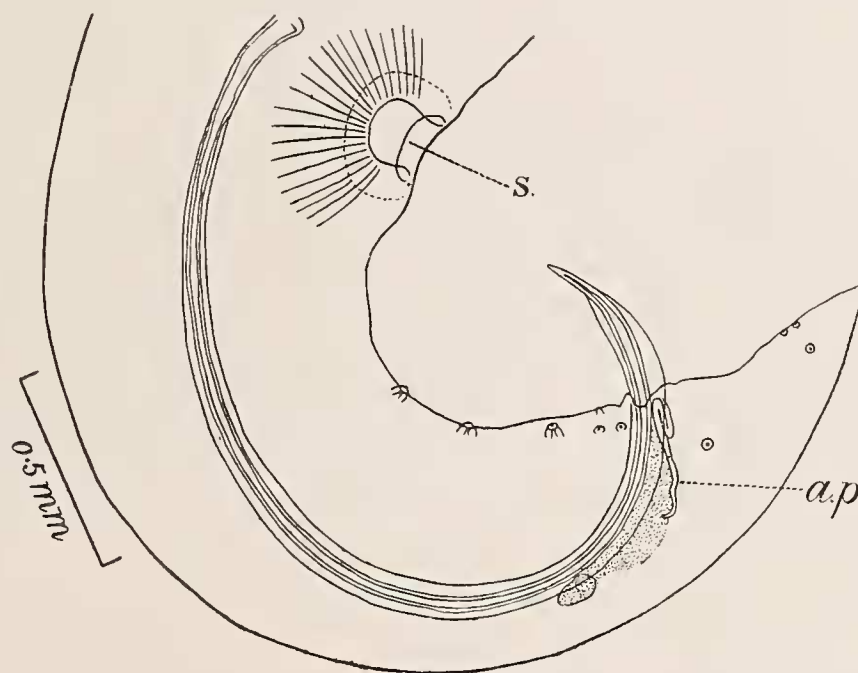


FIG. 49.—*Zanclophorus kempii*. Posterior end of male; lateral view.  
a.p., accessory piece; s., sucker.

The tail of the female is bluntly conical, and measures 0.55–0.8 mm. in length. There is a pair of caudal papillae at 0.27 mm. from the tip. The vulva is situated at 4.0–4.8 mm. from the posterior end. The vagina is simple and narrow, about 2 mm. long, and runs forward as usual from the vulva. The eggs are oblong-oval in shape and measure 0.125–0.137 mm.  $\times$  0.075–0.085 mm. The content is unsegmented.

It is always interesting to discover fresh cases of close relationship between the parasites of closely-related hosts, as showing how parallel evolution may be taking place in both hosts and parasites simultaneously. The present case is a very good example, neither the hosts nor their parasites having as yet developed sufficiently divergent characters to obscure their extremely close relationships.

Dr. Annandale has been good enough to supply us with the following interesting note on the hosts of our new genus:—

"*Testudo elongata* and *T. travancorica* belong to a small group of species which are very closely allied but remarkably isolated geographically. This group consists of four species: *T. travancorica*, from the southern part of the Malabar Zone of Peninsular India; *T. parallelus*, of which only a single specimen is known, from Chota Nagpur, in the middle of Peninsular India; *T. elongata*, with the widest range in the group, extending from Jalpaiguri in the extreme north-east of the plains of Bengal, through Assam, Burma and the northern part of the Malay Peninsula to Siam and Cambodia; and *T. forstenii*, from the island of Celebes. Discontinuous as the range of the group appears to be, the close structural similarity and the remarkable resemblance in facies indicate that the range was once continuous. Moreover, the existence of a single specimen from the interior of Peninsular India, captured many years ago, supports this view and suggests that rare annectant forms may linger on as yet undiscovered in inaccessible districts, perhaps of very limited area."

Superfamily **FILARIOIDEA**, Weinland, 1858.

Family **FILARIIDAE**, Claus, 1885.

Subfamily **FILARIINAE**, Stiles, 1907.

Genus "**Filaria**", *sens. lat.*

**Filaria haje**, Wedl, 1862 (?).

Young Filariid worms, perhaps belonging to this species, occurred twice in the intestine of the cobra (*Naja tripudians*) and twice in that of the banded krait (*Bungarus fasciatus*). All of these are immature forms, about 6–8 mm. in length, and without characters which would enable them to be assigned definitely to any well-established genus. They have a relatively long posterior glandular portion of the oesophagus. Wedl's (1862) description is very brief, and does not enable his species to be recognized with certainty. His specimens were found either free or encapsuled in the thoracic cavity, outside the lung. It is not indicated whether the present material occurred free in the lumen of the intestine or not.

**Filaria abbreviata**, Rud., 1819 (?).

(Fig. 50.)

The collection contains two female specimens of a Filariid from the orbit of *Saxicola*, sp. They are possibly referable to the above-named species, of which no full description appears to exist. Our material appears to agree fairly well with the account of *F. abbreviata* given by Molin (1858), and for this reason we tentatively refer it to this species.

The larger specimen is about 24 mm. long and 0.57 mm. in thickness. The anterior end of the body is abruptly attenuated and sharply truncated. The cuticle is smooth, and we are unable to detect the longitudinal rows of deciduous spines to which Molin refers. The mouth opens into a small buccal cavity which is about 0.032 mm. deep and 0.02 mm. in diameter. We are unable to distinguish any teeth at the base of the buccal cavity, but its wall is thrown into folds presenting an appearance which might easily have been mistaken for teeth. The oesophagus consists of two parts. The anterior portion is 0.25 mm. in length and distinctly more slender than the posterior portion. The latter measures 0.75 mm. in length and about 0.12

mm. in thickness. It is very slightly enlarged posteriorly. The nerve-ring surrounds the oesophagus at about 0.13 mm. from the anterior end, while the excretory pore opens at about 0.2 mm. from the head. The posterior extremity is rounded and not noticeably attenuated. The anus is small and subterminal. The vulva is situated close to the head, at about 0.45 mm. from the anterior end. There is a short transverse vagina, directed slightly backwards, from which two ovejectors are given off. The uteri and ovaries are both posterior, but a forwardly-directed loop in the ovejector of one of them indicates that this represents an anterior uterus. The eggs in the uterus measure about  $0.024 \times 0.017$  mm., and are in various stages of segmentation.

Henry and O'Zoux (1909) include *F. abbreviata* in a list of species of the subgenus *Diplotriana*. Walter (1866) gives a description and figure of a worm from *Motacilla alba*, which he regarded as *F. abbreviata*, but these make it quite clear that his material belonged to a species of *Diplotriana*. He also describes and figures as a Filariid under the name of *F. (attenuata?)*, from *Corvus corone*, *Garrulus glandarius*, *Saxicola rubicola* and *Falco tinnunculus*, a form which is clearly a *Diplotriana*; and it seems not improbable that the material in both of these instances was referable to *D. tricuspis*, which is recorded from a very similar range of hosts. It appears to us questionable whether the original *F. abbreviata* was in reality a *Diplotriana*.

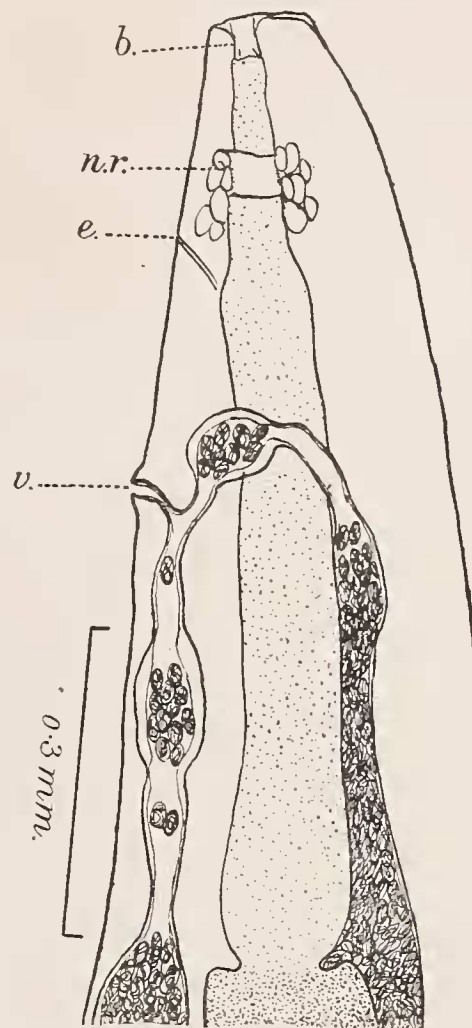


FIG. 50.—*Filaria abbreviata* (?). Anterior end of female; lateral view.

b., buccal cavity; e., excretory pore; n.r., nerve-ring; v., vulva.

### "*Filaria*," sp.

A single specimen of a different species from those mentioned under *F. haje* occurred in the intestine of a cobra. It is an immature form measuring about 20 mm. in length. The anterior end is broad and blunt, the posterior end more tapering. The oesophagus is relatively shorter than in "*F. haje*."

### *Filaria macrophallos*, Parona, 1889.

(Fig. 51.)

Hosts: *Varanus salvator*, *V. flavescens*, *V. nebulosus*, "Bengal monitor", *Varanus*, sp. Position: from the labels it is not quite clear whether the habitat is the actual cavities of the lungs, or the thoracic cavity. In three cases the lungs are mentioned, in one no position is specified, and in two the "intestines" are mentioned.

Great difficulty was evidently experienced in collecting whole specimens of this worm. We have only succeeded in finding one whole female among the material at our disposal, the rest consisting of much-tangled fragments.



The complete specimen came from an unnamed species of *Varanus*. It measures about 250 mm. in length and 1.4 mm. in thickness. The cuticle is marked throughout with prominent, raised, transverse wrinkles at irregular intervals, suggesting spines when seen in optical section. The head, which has a diameter about 0.45 mm., is squarish in front, the mouth often lying at the base of a funnel-like depression. There are two small, but prominent, chitinoid teeth, projecting forward, one on either side of the mouth. A little further back on each side there are three small, sessile, cephalic papillae. The oesophagus has a very short, narrow, anterior, muscular portion and a very long and wide, posterior, glandular portion. The length of the former is 0.6 mm.; of the latter, 30 mm. At its commencement the glandular portion occupies the whole width of the body-cavity. The nerve-ring surrounds the anterior portion somewhat behind its middle. Neither cervical papillae nor an excretory pore were seen.

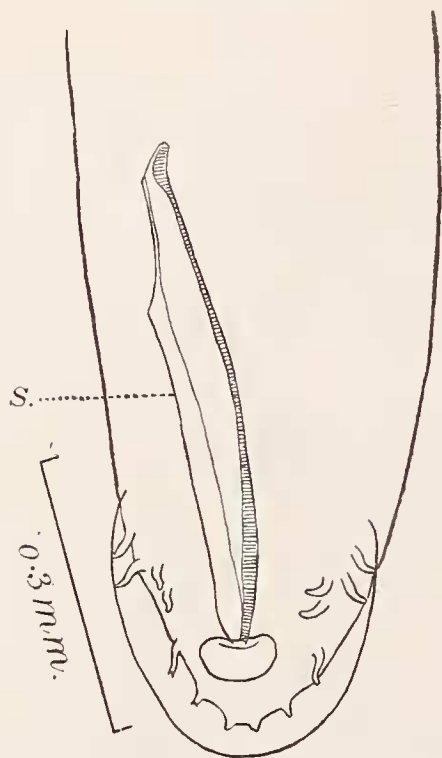


FIG. 52.—*Filaria varani*. Tail of male; ventral view.  
s., spicule.

The anus is almost terminal. The tail-end is bluntly rounded, and carries a pair of papillae at its extremity. The vulva opens at 1.15 mm. from the anterior end. The muscular vagina may run straight back, or may be much convoluted. The ova (fig. 51) are of very characteristic shape, somewhat resembling a barrel, with an annular thickening near each pole. They measure  $0.05 \times 0.03$  mm., have thick shells, and contain coiled embryos when ready for laying.

This species, according to Henry and O'Zoux (1909), should be referred to the genus *Diplotriana*, but with this view we are unable to agree.

### *Filaria varani*, sp. nov.

(Fig. 52.)

A single male individual from *Varanus flavescens* does not agree with the male of *F. macrophallos*, and must be regarded provisionally as belonging to a new species. It measures about 108 mm. in length and 0.7 mm. in thickness. The characters of the anterior end are similar to those of *F. macrophallos*. The diameter of the head is 0.23 mm. The anterior portion of the oesophagus is 0.35 mm. in length, and the posterior portion 16 mm.

The tail (fig. 52) is 0.16 mm. long, and there are well-developed caudal alae, which are continuous round

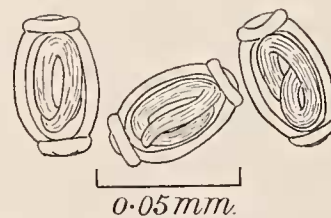


FIG. 51.—*Filaria macrophallos*. Ova.

the posterior extremity. Only one spicule<sup>1</sup> appears to be present, and this, from its position, seems to be that of the right side. It is a very broad structure, of characteristic shape (fig. 52, s.), and measures 0.6 mm. in length and 0.07 in width. There are seven pairs of caudal papillae, of which four are preanal. These and the most anterior postanal pair have long peduncles. Their arrangement is best indicated by means of the figure. The posterior lip of the cloacal aperture is tumid.

Genus **Setaria**, Viborg, 1795.

**Setaria**, sp. (?).

Three larvae, taken from "inner surface of cartilage" of a Javan mouse deer, or chevrotain (probably *Tragulus javanicus*).

The worms are of a Filariid type, but are too immature to show recognizable generic characters.

Subfamily **DIPLOTRIAENINAE**, Skrjabin, 1916.

Genus **Diplotriaena**, Railliet and Henry, in Henry and O'Zoux, 1909.

**Diplotriaena tricuspis** (Fedchenko, 1874).

The collection includes one male specimen belonging to this species, from Blandford's laughing-thrush (*Trochalopteron meridionale*).

Subfamily **MICROPLEURINAE**, nov.

Genus **Micropleura**, v. Linst., 1906.

**Micropleura vivipara**, v. Linst., 1906.

(Figs. 53, 54.)

Host: Gharial (*Gavialis gangeticus*). Position: Liver.

For the purpose of confirming the determination of this material, we were fortunate in being able to obtain from the Indian Museum five examples from the type series. These, as well as the new material, unfortunately proved to be all females, but we are in a position to add a few details to the description furnished by von Linstow (1906 a).

The dimensions of the female may be slightly larger than those given by that author, reaching about 43 mm. in length and 1 mm. in thickness. The cuticle, although without striations, is not perfectly smooth, as stated by von Linstow. There are distributed rather irregularly about its surface, especially on the hinder portion of the worm, little longitudinal series of from 2 to 7 very minute, raised, papilla-like structures. There is an appearance of a remarkable structure lining the body-cavity—i.e. within the musculature. This "structure" takes the form of a highly refringent network, strongly suggestive of a series of longitudinal tubules connected by smaller tubules running transversely. It seems probable, however, that this appearance is an artifact—it may perhaps be the result of the fluid contained in the

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<sup>1</sup> In *F. macrophallos* there are two unequal spicules. Our specimen does not appear to be in any way damaged.

body-cavity having coagulated on fixation and formed a membrane which is thrown into folds in the peculiar pattern indicated.

The mouth is, as v. Linstow states, without lips. There are six small cephalic papillae, two lateral and four sublateral. The lateral papillae are slightly larger than the others. The diameter of the head at the level of the papillae is 0.15 mm. The

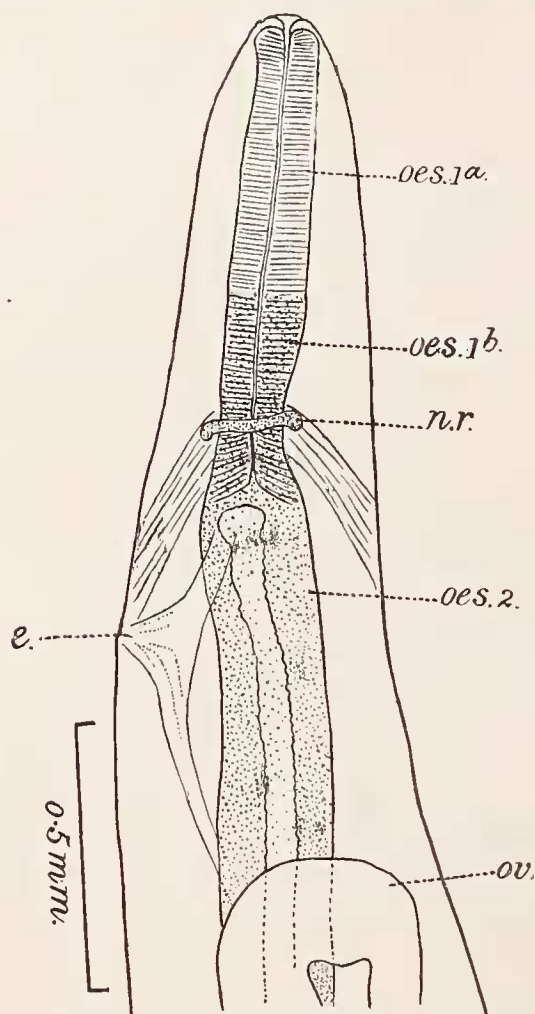


FIG. 53.—*Micropleura vivipara*. Anterior end of female; lateral view.

e., excretory pore; n.r., nerve ring oes.1<sup>a</sup>., oes.1<sup>b</sup>., two portions of anterior division of oesophagus; oes.2., posterior division of oesophagus; ov., oviduct.

oesophagus is distinctly divided into an anterior, narrow, muscular portion and a much longer and wider, posterior, glandular portion. The muscular portion measures only 0.75–0.9 mm. in length, while the total length of the oesophagus is 3.25–3.5 mm. The muscular portion itself is slightly granular in appearance for nearly the posterior half of its length. It is surrounded by the nerve-ring at 0.67–0.8 mm. from the anterior end.

Contrary to the statement of v. Linstow, a minute excretory pore is present on the ventral surface a little behind the junction of the two portions of the oesophagus (at 1.0–1.1 mm. from the anterior end), and connected with this there is a structure apparently representing the excretory “bridge,” into which faint indications of ducts can be seen coming from both anterior and posterior directions. These ducts, however, have not been traced along the lateral fields, nor has any connection been observed between them and the peculiar “network” already referred to.

The vulva is very hard to see in mature females, even when perfectly cleared, owing to the dense mass of embryos contained in the uterus. It is situated slightly in front of the middle of the body. The vagina consists of a very narrow, non-muscular duct running through the body-wall in a postero-dorsal direction from the opening, and a very short, somewhat muscular portion returning towards the head and connected with the uterus. The whole of the vagina is not more than 0.4 mm. in length. The two branches of the uterus are directly opposed, and form one continuous straight tube joining the ovaries, which are situated at opposite ends of the body-cavity. This tube fills the whole width of the body-cavity with the exception of the space occupied by the very narrow intestine, which runs in close contact with the body-wall. The ovaries are exceedingly short in proportion to the length of the worm. They are usually reflexed, but occasionally continued in a straight line with the uterus. They



are connected by narrow ducts with the respective ends of the latter. The development of the embryos appears to be very rapid, the uterus being entirely filled, from end to end, with young apparently fully-formed and not enclosed in membranes. These embryos have, as v. Linstow observes, a cuticle marked with conspicuous transverse striations, a blunt head and a long, tapering tail.

The tail of the adult female (fig. 54) is rounded at the tip, and measures 0.2–0.35 mm. in length. At 0.1–0.14 mm. from the tip, and somewhat towards the ventral side, there is a pair of large, prominent caudal papillae.

This genus, with the uteri directly opposed, the vulva placed far back from the head, the short ovaries, and the spicules of the male (according to v. Linstow) of equal length, does not appear to fit very well into any existing subfamily of Filariidae. It seems justifiable, therefore, to regard it as the type of a new subfamily, Micropleurinae.

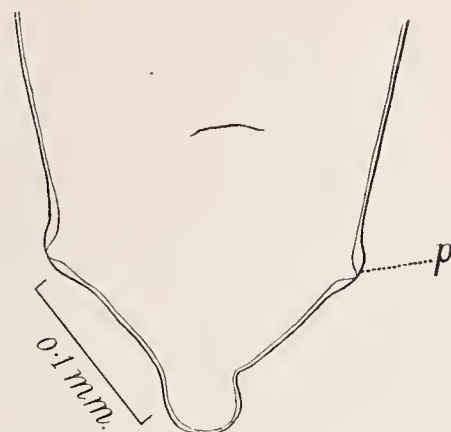


FIG. 54 — *Micropleura vivipara*. Tail of female; ventral view.  
p., caudal papilla.

Superfamily **SPIRUROIDEA**, Railliet and Henry, 1915.

Family SPIRURIDAE, Örley, 1885.

Subfamily ACUARIINAE, Railliet, Henry and Sisoff, 1912.

Genus **Acuaria**, Bremser, 1811.

**Acuaria (Acuaria) anthuris** (Rud., 1819).

One female, which we assign to this species, was collected from the Red-billed Blue magpie (*Urocissa occipitalis*).

**Acuaria (Echinuria) leptoptili** (Gedoelst, 1916).

(Figs. 55, 56.)

This form was collected from the Adjutant (*Leptoptilus dubius*), at Calcutta. The species was described by Gedoelst (1916) from females only. The type host was *Leptoptilus crumenifer*.

The females in the present collection measure from 13 to 15 mm. in length, and about 0.36 mm. in thickness; the males 11 to 11.5 mm. and 0.234 mm. respectively. The cuticle has fine transverse striations about  $4\ \mu$  apart. At the anterior end it is ornamented with "cordons." These cordons actually consist of a continuous band folded so that two folds lie dorsally and two ventrally. The transverse portions of the band are arranged so that they run across the lateral lines posteriorly and across the dorsal and ventral surfaces anteriorly. The cordons are 0.02 mm. broad and they extend backwards to a point about 1.1 mm. from the anterior end. The posterior transverse portions show a slight forward bend as they cross the lateral lines. The disposition of the longitudinal portions is not markedly asymmetrical or inclined to-

wards the ventral surface, as described by Seurat (1919), for *Echinuria*, Soloviev, 1912, and there are no cuticular spines. The cervical papillae are prominent and slender and are situated a little behind the lateral bends of the cordons.

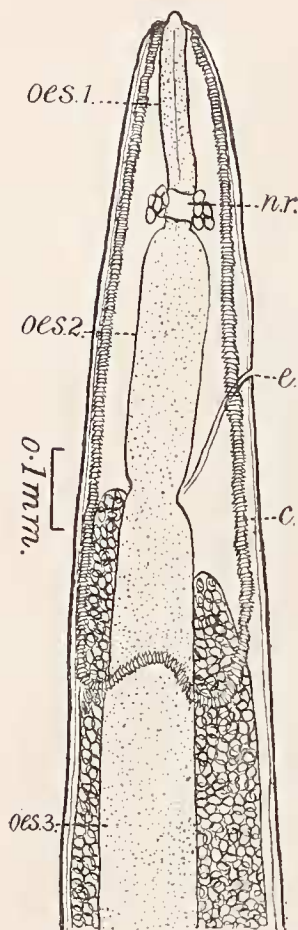


FIG. 55.—*Acuarina* (*Echinuria*) *leptoptili*. Anterior end of female; lateral view.

c., cordon; e., excretory pore; n.r., nerve-ring oes.1., oes.2., oes.3., three divisions of oesophagus.

The head is small and provided with two simple lips, and is not constricted off from the body. The oesophagus consists of the usual three portions, a pharynx, a muscular portion, and a glandular portion. These measure 0.31, 0.41, and 2.3 mm. respectively. The nerve-ring surrounds the oesophagus at about 0.27 mm. from the anterior extremity, while the excretory pore opens at about 0.54 mm. from the head. The vulva opens at about 0.17 mm. from the tip of the tail. Its anterior lip is modified into a prominent bulla. From the vulva there is a long, straight, muscular-walled vagina which runs forward for about 1.4 mm. and then turns transversely to join the uterus. The species may be considered to be monodelphic, the posterior set of organs being represented merely by a blind sac-like uterus which runs back to the vicinity of the vulva. The anterior uterus runs forward to within 1.75 mm. of the anterior end of the body, the ovary commencing at this point and running backwards. In a mature specimen practically the whole of the body-cavity is occupied by the uterus, which is packed with eggs containing fully-developed embryos. The ova measure  $0.028 \times 0.018$  mm. The anus is situated at 0.05 mm. from the tip of the tail.

The tail of the male forms several turns of a spiral. Membranous alae are present, extending for about 0.7 mm. from the tip of the tail. The cloaca opens at 0.115 mm.

from the tip of the tail. There are nine pairs of supporting papillae in the alae; 4 preanal pairs, about equidistant from each other and close to the cloaca, and 5 postanal. The postanal papillae are arranged as follows: four pairs in a group, occupying the posterior half of the tail, and one pair about midway between this group and the anus. The papillae are all stalked and slender, the preanal ones being much longer than the postanal. The spicules are unequal and dissimilar. The right spicule is long and slender. It is gently curved, and if partly extruded the distal portion may be generously incurved but it is not twisted. It measures 0.65–0.675 mm. The left spicule (fig. 56), is short and very much curved. It lies roughly at right angles to the long axis of the right spicule, measures 0.19–0.21 mm. in length, and is twisted and flanged. The root of the spicule is expanded. Its edges are faintly serrated in the part towards the tip. The testicular coil runs forward to within 3.5 mm. from the head.

A genus *Echinuria* (genotype *E. jugadornata*) was erected by Soloviev in 1912, the month of publi-



cation being September. In December of the same year Railliet, Henry and Sisoff published a note on the relationships of the members of the genus *Acuaria*, Bremser, 1811, and erected a new sub-family Acuariinae containing the genera *Acuaria* (type), Bremser, 1811, *Cosmocephalus*, Mol., 1858, *Histiocephalus*, Dies., 1851, and *Streptocara*, Raill., Hen. and Sis., 1912. The members of the genus *Acuaria* were separated as far as possible into five sub-genera, viz., *Acuaria*, *Cheilospirura*, Diesing, 1860, *Dispharynx*, Raill., Hen. and Sis., 1912, *Synhimantus*, Raill., Hen. and Sis., 1912, and *Hamannia*, Raill., Hen. and Sis., 1912.

The sub-genus *Hamannia* is recognised by Seurat (1919) as a synonym of *Echinuria*, Soloviev, 1912. While he retains full generic rank for the latter, for his new genus of 1918, *Chevreuxia*, and for *Rusguniella*, a genus erected in the same paper, he assigns species to the following sub-genera of *Acuaria*: *Acuaria*, *Dispharynx* and *Synhimantus*.

The emended diagnosis of the genus *Acuaria*, Bremser, 1811, given by Railliet, Henry and Sisoff, runs as follows: Acuariinae without vesicular swelling at the anterior end, but bearing four cutaneous cordons in the form of gutters or bands salient from or countersunk in the cuticle, these cordons extending sometimes directly backwards, more often returning forwards or even united two by two across the lateral surfaces. Parasites of the oesophagus, ventriculus, or gizzard. Type, *Acuaria anthuris* (Rud., 1819).

Accepting this definition, then, we can see no reason why *Echinuria*, Soloviev, 1912, *Rusguniella*, Seurat, 1919, or *Seuratia*, Skrjabin, 1916, should be given full generic rank.

The suggested arrangement, then, is as follows: ACUARIINAE, Raill., Hen. and Sis., 1912: Genotype, *Acuaria*, Bremser, 1811. Other genera: *Cosmocephalus*, Mol., 1858; *Histiocephalus*, Dies., 1851; *Streptocara*, Raill., Hen. and Sis., 1912; *Chevreuxia*, Seurat, 1918.

Genus *Acuaria*, Bremser, 1811. Sub-genera: *Acuaria*, Bremser, 1811, *emend.* Raill., Hen. and Sis., 1912; *Cheilospirura*, Dies., 1860, *emend.* Raill., Hen. and Sis., 1912; *Dispharynx*, Raill., Hen. and Sis., 1912; *Synhimantus*, Raill., Hen. and Sis., 1912; *Echinuria*, Soloviev, 1912; *Rusguniella*, Seurat, 1919; *Seuratia*, Skrjabin, 1916.

Sub-genus *Echinuria*, Soloviev, 1912 (Synonym *Hamannia*, Raill., Hen. and Sis., 1912). Diagnosis after Raill., Hen., and Sis. (1912):—*Acuaria* with cuticular cordons non-recurrent but anastomosed in pairs across the lateral lines. Body sometimes spiny. Males with spicules unequal and unlike. Four or five pairs of postanal papillae.

Habitat: ventriculus or gizzard.

Type, *Acuaria (Echinuria) jugadornata*, Soloviev, 1912.

Other species: *A. uncinata* (Rud., 1819); *A. contorta* (Molin, 1858); *A. longeornata* (Mol., 1860); *A. calcarata* (Mol., 1860); *A. spinifera* (Schneider, 1866); *A. squamata* (v. Linst., 1883); *A. phoenicopteri* (Seurat, 1916), *A. leptoptili*, Gedoelst, 1916.

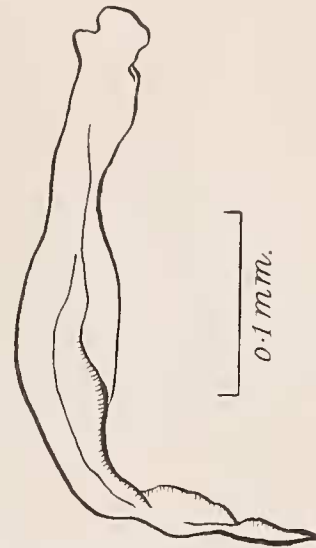


FIG. 56.—*Acuaria (Echinuria) leptoptili*. Left spicule; lateral view.

Subfamily *PHYSALOPTERINAE*, Stossich, 1898 (*vide* Stiles and Hassall).

Genus *Physaloptera*, Rud., 1819.

*Physaloptera alata*, Rud., 1819.

One immature female specimen was collected from Montagu's harrier (*Circus cineraceus*).



**Physaloptera praeputialis**, v. Linst., 1889.Syn. *Chlamydonema felineum*, Hegt, 1910.

Specimens of this curious form occurred in the following hosts:—

Fishing cat (*Felis viverrina*).Jungle cat (*Felis chaus*).Leopard cat (*Felis bengalensis*).Leopard (*Felis pardus*).

We are of the opinion that the form described by Hegt (1910) and discussed by Nierstrasz (1910) is identical with von Linstow's species, and that there is no justification for the erection of a separate genus *Chlamydonema*. The species has all the characters of a true *Physaloptera*, though complicated or obscured to a varying extent by the development of a cuticular caudal sheath.

**Physaloptera**, sp.Host: Indian fox (*Vulpes bengalensis*). Position: stomach.

Apparently the only species of *Physaloptera* recorded in foxes is *P. cesticillata*, Sonsino, 1889, from the Fennec fox (*Megalotis zerda*) of Northern Africa. The present material consists only of a single female specimen, and, in the absence of a male, it is impossible to identify it with Sonsino's species. In the characters of the lips, and in some other respects, our specimen appears to approach very closely to *P. digitata*, Schneider, 1866. This species, however, has only been recorded from the puma (*Felis concolor*) in Brazil, and without examining further material it would be unwise to suggest the identity of this with a form from the Indian fox.

**Physaloptera**, sp.

A number of immature forms, measuring about 5–7 mm. in length, were found in the intestine of a "Raket Bausi" (*Coluber*, sp.). In the apparent absence of the inner teeth of the lips they resemble *P. colubri* (Rud., 1819), according to von Drasche's (1883) account of that form; but since there are no sexually mature specimens the determination remains uncertain.

Family CAMALLANIDAE, Railliet and Henry, 1915.

Genus **Camallanus**, Railliet and Henry, 1915.**Camallanus kachugae**, sp. nov.

(Figs. 57–59.)

Host: *Kachuga smithii*. Locality: Ferozpore, Punjab.

This species has the typical characters of the genus, which appear to vary little except in small details in different species. The worms, as indicated by the collector's label, had the usual reddish colour during life. The total length is 10.9–14.5 mm. in the male and 20.8–22.0 mm. in the female. The male has a maximum thickness of 0.3–0.37 mm., the female of 0.45–0.5 mm. The cuticular striations are fine, the interval not exceeding 5  $\mu$ . The dorso-ventral diameter of the head, measured at the

anterior angles, is 0.13–0.15 mm. in the male, 0.17 mm. in the female. The chitinous buccal valves are slightly broader than long, their length (not including the posterior ring) being 0.11–0.13 mm. and their width about 0.14–0.16 mm. The number of longitudinal ridges on each valve is either eight or ten, the latter number being seen only in large specimens. The posterior ring of the buccal apparatus has a diameter of 0.1 mm. The dorsal and ventral “tridents” are well developed, and the middle prong measures 0.08–0.1 mm. in length. The head bears three papillae on each side near the extremity. The oesophagus shows the usual division into an anterior, clear, muscular portion and a posterior, more opaque, glandular portion. The former is distinctly club-shaped, and (measuring from the extremity of the head) 0.54–0.66 mm. in length. The total length of the two portions (from the head-end) is 1.18–1.55 mm. The minute, bristle-like cervical papillae are situated at 0.5–0.55 mm., the nerve-ring at 0.2–0.23 mm., and the excretory pore at about 0.5 mm., from the anterior end. The intestine is very narrow, considerably more so than the oesophagus.

In the male the tail measures about 0.21 mm. in length. The alar region is somewhat thicker than the preceding portion of the body. The ventral region between the alae is probably capable of being depressed by the action of the well-developed caudal muscles, so as to produce the effect of a sucker. The number and general arrangement of the caudal papillae are the same as those described for certain other species (*C. microcephalus*, *C. americanus*). Unfortunately, although a number of species of *Camallanus* have been described, the majority of the descriptions are very incomplete, and it is impossible to determine whether the number of papillae is constant throughout the genus. It seems probable, however, that the seven pairs of rib-like preanal papillae, projecting into the alae, will be found to be constant. The present species has, in addition to these (fig. 58), six pairs of postanal papillae and two small pairs of adanal papillae, as in the two other species cited. Their arrangement agrees more closely with that of *C. microcephalus* than that of *C. americanus*, in that the first, or most posterior, pair occupies an isolated position close to the tip of the tail. The second pair is also isolated. Pairs 3 to 5 form a group, close together. All these are lateral in position, while the sixth pair is more ventrally situated, just behind the cloaca. The two small adanal pairs are not indicated in the figure. The two spicules are very

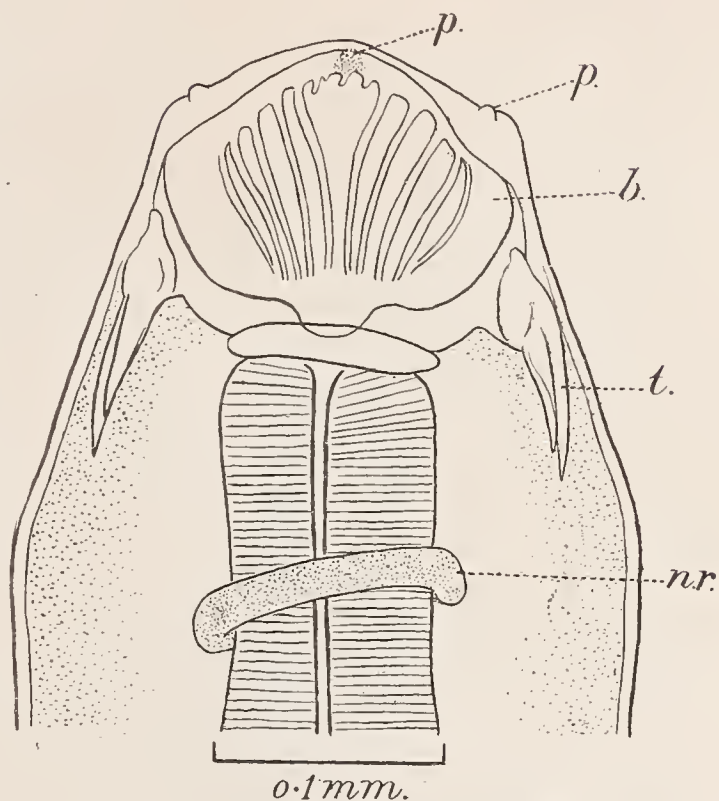


FIG. 57.—*Camallanus kachugae*. Head of female; lateral view.

b., buccal valve; n.r., nerve-ring; p., p., papillae; t., “trident.”



unequal. The right spicule is fairly stout and measures about 0.97 mm. in length. It has no barb or prong, such as is found near the tip in several species, but the tip appears to be simple and finely pointed. The left spicule is very slender and delicate, and measures only about 0.43 mm. in length.

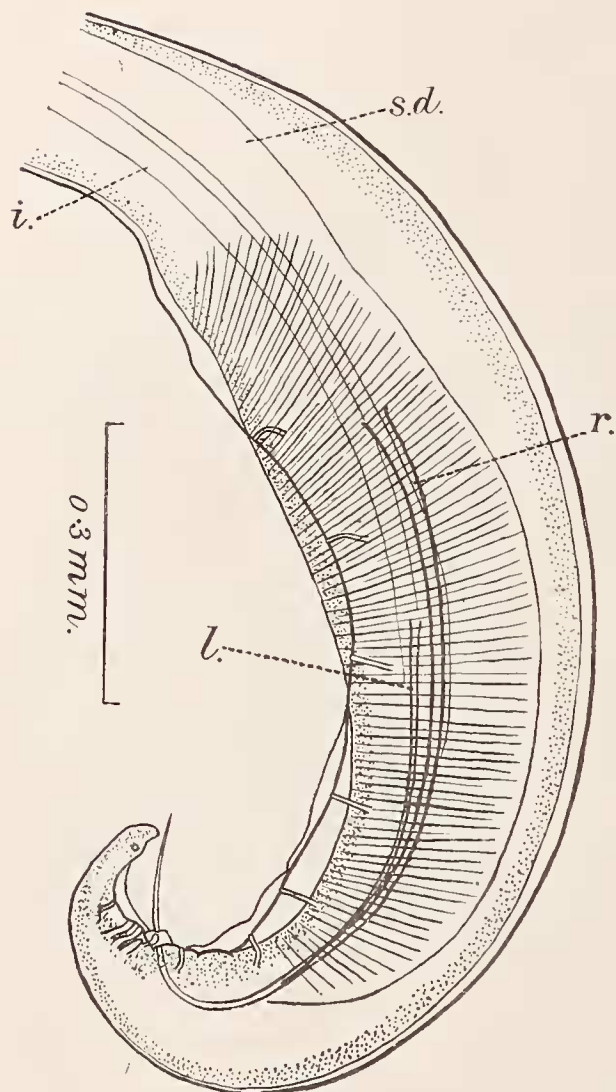


FIG. 58.—*Camallanus kachugae*. Posterior end of male; lateral view.

i., intestine; l., left spicule; r., right spicule; s.d., sperm-duct.

The worm is, as usual, viviparous.

This form is extremely closely related to the European *C. microcephalus* (Duj., 1845). On comparison, however, with specimens which we believe to belong to that species, we find that, apart from size, which is too variable to be of much importance, *C. kachugae* differs from them in the following points:—

(1) The “tridents” of the buccal apparatus are of slightly different shape, their outer prongs being longer and more flattened and expanded at the free end in *C. microcephalus* than in *C. kachugae*. The colour of the whole buccal apparatus, and especially of the ring and tridents, is much darker in *C. microcephalus*.

(2) The longer (right) spicule of the male is simple in *C. kachugae*, pronged in *C. microcephalus*. In the former it measures 0.97 mm. in length, in the latter 0.85 mm.

(3) The lips of the vulva in *C. kachugae* are much more strongly developed than in *C. microcephalus*. In the latter the posterior lip is often completely hidden by the anterior lip.

As regards other species already described from tortoises, *C. americanus*, Magath, 1919, has a barbed

In the female the tail is about 0.3 mm. long, finger-shaped, rather blunt, and slightly bifid at the tip. There is a pair of caudal papillae at 0.17 mm. from the tip, situated in little dimples in the cuticle. The vulva is in front of the middle of the body, at 9.1–10.4 mm. from the anterior end. It has exceedingly prominent lips, the anterior lip being considerably larger than the posterior, and overlapping it. Each of the lips (fig. 59) consists of a cuticular swelling with granular contents, and has the appearance of being divided internally into a number of compartments by partitions originating from the cuticle. The muscular vagina is very narrow, running back almost in a straight line for about 2 mm. At its inner end it gradually widens into the short unpaired portion of the uterus, which continues to run posteriorly. The two uterine branches are directly opposed. The posterior branch, as usual, has no ovary, but ends blindly at a short distance in front of the anus. This blind



or pronged right spicule in the male. *C. dumerilii* (Perrier, 1871), as also the *C. dumerilii*, Perrier of v. Linstow, 1897 and 1909, and consequently the *C. confusus* of Railliet and Henry (1915), are probably all synonymous with *C. microcephalus*. *C. trispinosus* (Leidy, 1851) and *C. undulatus*, Railliet and Henry, 1915 (= *Cucullanus viviparus*, v. Linst., 1906, renamed), are so briefly described that it is doubtful whether the species can be identified. *C. roseus* (Leidy, 1851) probably belongs to another genus.

Magath (1919) is of the opinion that the *C. microcephalus* of Seurat (1915), from *Clemmys leprosa*, is a different species from *C. microcephalus* (Duf.), and proposes for it a new name, *C. seurati*. He considers it questionable whether any form can be identified from Dujardin's description, and yet appears to find in the two descriptions sufficient grounds for concluding that the species are distinct. Such discrepancies as there are in these descriptions, however, are in matters of measurement, and it is clear that these are subject to great variation. We feel, therefore, that Magath's view is somewhat premature, and regard Seurat's determination as correct, unless a detailed comparison with material from *Emys orbicularis* should prove the contrary.

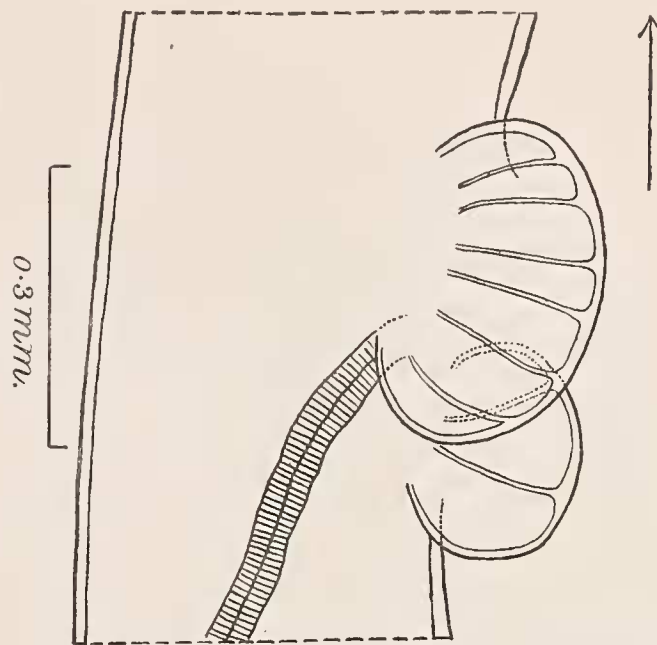


FIG. 59.—*Camallanus kachugae*. Vulvar region of female; lateral view.

The arrow points in the direction of the head. Intestine and uterus omitted.

#### Genus *Camallanides*, nov.

#### *Camallanides prashadi*, sp. nov.

(Figs. 60–63.)

Host: Banded krait (*Bungarus fasciatus*).

The buccal apparatus in this species differs somewhat from that typical for the genus *Camallanus*. The paired valves, on superficial examination, appear to be represented by four separate masses of brown chitin. Actually, these are joined together in lateral pairs by relatively thin plates on their inner surfaces, so that they are really pronounced external thickenings of the usual buccal valves. The usual rib-like structures, terminating in tooth-like projections anteriorly, are present on each inner plate to the number of about 14. The "tridents" are represented by simple chitinoid rods of rather irregular shape and of a yellow colour. These are connected at their bases with a dorsal and a ventral chitinoid body, lying opposite to the edges of the buccal valves.

The male measures 5.8–6.6 mm. in length and 0.21–0.25 mm. in thickness. The female is more than twice as large (14.2–17.7 mm. long and 0.4–0.47 mm. in maximum thickness). The cuticular striations are very fine and indistinct, at intervals of about 3–4  $\mu$ . The diameter of the head, measured dorso-ventrally at the anterior corners, is 0.08–0.09 mm. in the male, 0.12–0.13 mm. in the female. There appear to be three pairs of cephalic papillae. The measurements of the buccal valves are: length,

0.06 mm. in male, 0.09–0.1 mm. in female; width (dorso-ventral), 0.075 mm. in male, 0.1 mm. in female. The length of the rods representing the tridents is about 0.06 mm.

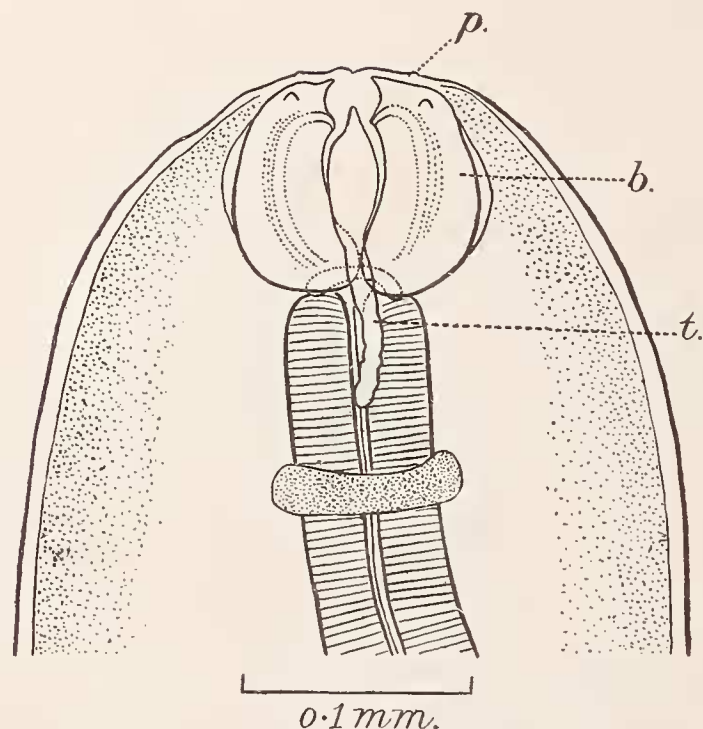


FIG. 60.—*Camallanides prashadi* Head of female; dorsal view.

b., buccal valve; p., papilla; t., "trident."

the general structure characteristic of *Camallanus*, with well-developed alae and caudal muscles. The tail is very short (a little over 0.06 mm.), sharply pointed, and usually curled ventrally, with its tip hidden by the alae. The caudal papillae are elongate and rib-like, diminishing in size towards the tip of the tail. As in *Camallanus*, there are seven pairs of preanal papillae, projecting into the alae. There are two large pairs curving inwards towards the ventral surface at the sides of the cloaca, and five more pairs of lateral postanal papillae. The three anterior pairs of these are relatively large and close together. The spicules are markedly unequal in size and character. The right spicule is stout and provided with alae for the greater part of its length. It is about 0.24 mm. long. Its tip is curled into a hook, but there is no barb. The left spicule is without alae, slender and

in the male, 0.07–0.1 mm. in the female. The posterior ring of the buccal apparatus has a diameter of 0.033 mm. in the male and 0.045 mm. in the female. The oesophagus has the same structure as in *Camallanus*, the anterior muscular portion measuring (from the extremity of the head) 0.38 mm. in length in the male, 0.47–0.5 mm. in the female. The distance from the head-end to the posterior end of the glandular portion is 0.8 mm. in the male, 1.02–1.08 mm. in the female. The nerve-ring is situated at 0.15 mm. in the male, 0.19 mm. in the female, from the anterior end; the excretory pore at 0.25 mm. (male), 0.31 mm. (female); and the minute, bristle-like, cervical papillae at 0.28 mm. (male), 0.35 mm. (female).

In the male, the caudal region has

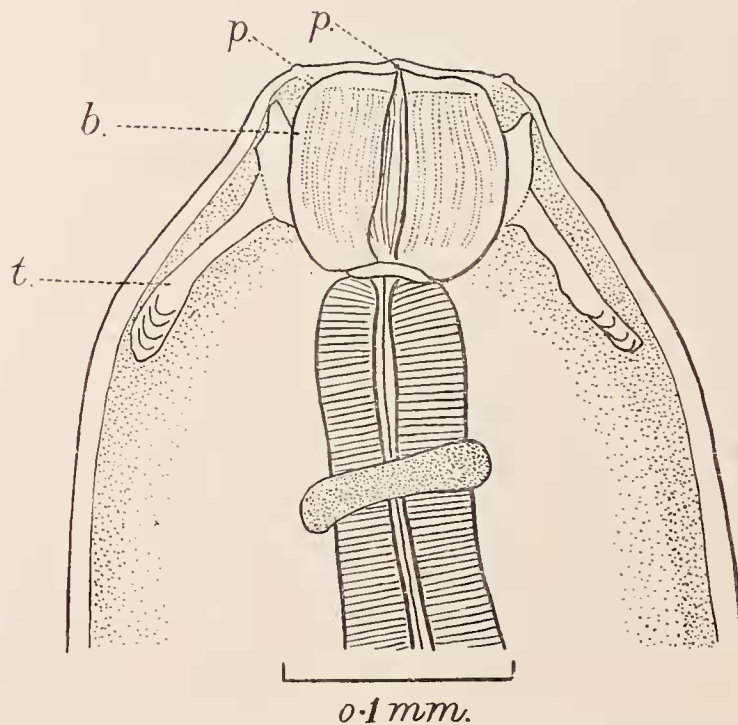


FIG. 61.—*Camallanides prashadi*. Head of female; lateral view.

Lettering as in fig. 60.



tapering, and measures only about 0.14 mm. in length. There is a yellow chitinous accessory piece, more or less triangular in shape and measuring about 0.025 mm. in length.

In the female the tail is relatively long (0.4–0.6 mm.), and gradually tapering, with the exception of a slight thickening just before the conical tip. No caudal papillae were seen. The general arrangement of the genital organs is that seen in *Camallanus*, but the prominent lips of the vulva are here modified into a tubular appendage (fig. 63,) somewhat flattened dorso-ventrally and projecting freely from the body-wall in a posterior direction to a distance of 0.3–0.4 mm. This appendage originates at a point a little behind the anterior third of the length of the worm (at 5.9–6.1 mm. from the head-end). The vulvar aperture is situated on the ventral surface of this structure, near its extremity. The muscular vagina runs from the opening to the base of the appendage, and then turns back just within the ventral body-wall, running

straight back for about 2 mm. before opening into the uterus. The posterior branch of the uterus is, as in *Camallanus*, without an ovary. The worm is viviparous, both branches of the uterus, in mature females, being filled from end to end with free embryos.

We have considered it necessary to make this form the type of a new genus, on account of the following important characters in which it differs from *Camallanus*:—

- (1) The structure of the chitinous buccal valves, each of which has two large thickenings, giving the appearance of two separate masses of chitin.
- (2) The reduction of the “tridents” to simple, rod-like structures.

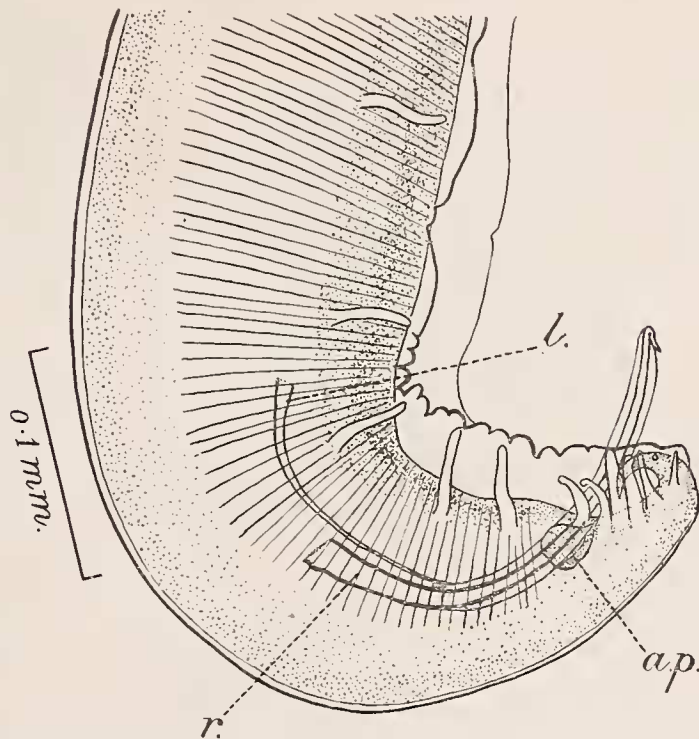


FIG. 62.—*Camallanides prashadi*. Posterior end of male; lateral view.

a.p., accessory piece; l., left spicule; r., right spicule.

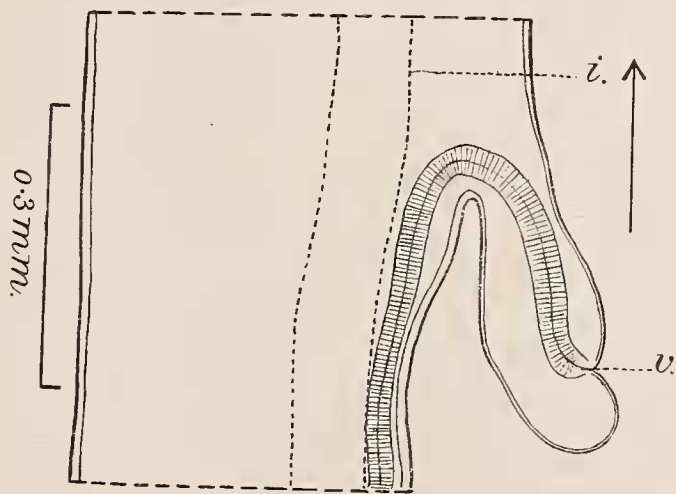


FIG. 63.—*Camallanides prashadi*. Vulvar region of female; lateral view.

i., intestine; v., vulva. Uterus, full of embryos, omitted. The arrow points in the direction of the head.



(3) The alate condition of the right spicule, and the presence of an accessory piece, in the male.

(4) The presence of a tubular appendage, carrying the vulva, in the female.

A nematode has been described under the name *Camallanus bungari* from *Bungarus candidus*, in Java, by MacCallum (1918). The description of this form is not easy to understand, but it appears impossible to identify it with the species just described, the most striking difference being that, whereas in the present form the vulva is situated on a very conspicuous outgrowth from the body-wall, in *C. bungari* it appears to have had no prominent lips, and to have been so inconspicuous that some doubt remained as to its position. At the same time it may be observed that the accompanying figure in MacCallum's paper (*l.c.*, fig. 65) gives quite a different impression from the description, and shows an arrangement of the uterus and vagina hitherto unknown in the genus *Camallanus*.

Family GNATHOSTOMIDAE, Railliet, 1895, *emend.* Baylis and Lane, 1920.

Subfamily SPIROXYINAE, Baylis and Lane, 1920.

Genus *Spiroxys*, Schneider, 1866.

*Spiroxys annulata*, sp. nov.

(Figs. 64, 65.)

Host: *Chitra indica*. Position: stomach. Locality: Budha Stream, Ludhiana, Punjab.

This species, which was collected by Dr. Bains Prashad, approaches closely to the only other Indian species of *Spiroxys* at present known (*S. gangetica*, Baylis and Lane, 1920). In size, and also in the dimensions of many of its organs, it is intermediate between that species and the genotype, *S. contorta* (Rud.).

The lips, when seen in a lateral view, have a very similar shape to those of *S. gangetica*, the dorsal and ventral lobes being placed almost at right angles to the middle lobe. In a dorsal or ventral view, however, the thickness of the lips is relatively much less than in *S. gangetica*, and they are seen to be much more wedge-shaped (fig. 64), so that the head has not the same square appearance in such a view. The six pointed teeth on each lip (two on each lobe), characteristic of *S. gangetica*, are absent in the present species. The cuticular thickening on the inner surface of the middle lobe is well developed, but does not form a distinct tooth at its apex.

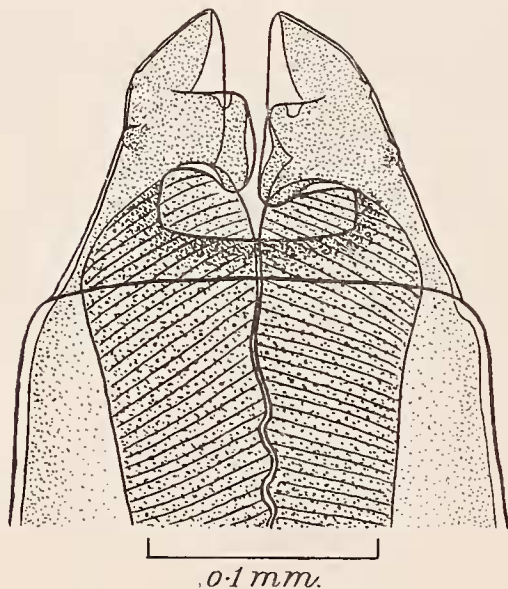


FIG. 64.—*Spiroxys annulata*. Head of female; dorsal view.

The total length is from 20 to 25.4 mm. in the male, and 30 to 34 mm. in the female.

The maximum thickness is 0.5–0.6 mm. in the male, 0.8–0.85 mm. in the female. The diameter of the lips, measured dorso-ventrally, is 0.16 mm., and their length 0.06 mm. The transverse striations of the cuticle are exceptionally coarse (up to

0.025 mm. apart), forming a series of rings with prominent posterior edges, so that in optical section the outline of the body has a rather saw-like appearance.

There is a well-marked cuticular collar (seen also in *S. gangetica*) just behind the base of the lips (fig. 65, c).

The tail is unusually short (about 0.2 mm.) in both sexes. The length of the oesophagus (measured from the anterior extremity of the lips) is 2.8–3.5 mm. Except for a short portion at the anterior end, which is purely muscular, its walls contain many pocket-like glands arranged in several linear series. The cervical papillae, which are prominent and resemble small, backwardly-directed spines, are situated at a little over 1 mm. from the anterior end. The nerve-ring is at 0.62–0.65 mm., and the excretory pore at 0.8 mm., from the anterior end.

The inflation of the caudal alae in the male is very pronounced. As usual in the genus, they are joined anteriorly by an inflated cushion of cuticle which passes over the ventral surface in front of the cloaca. There is also a sucker-like preanal depression, produced by the well-developed caudal muscles, within the bursa-like area thus marked out. There is nothing worthy of special notice in the caudal papillae, which are present to the usual number (11 pairs) and arranged as in the other members of the genus. The lateral papillae are, as usual deeply buried in the inflated alae. The small pre- and postcloacal pairs are sessile. The spicules are nearly equal in length (from 1.6 to 2.3 mm.), slender, cylindrical and finely pointed.

The tail of the female is sharply conical, with the tip bent ventrally. The caudal papillae are at 0.17 mm. from the tip. The vulva is situated slightly behind the middle of the body, at 13.8–15.5 mm. from the posterior extremity. The muscular vagina is very narrow, running forward from the vulva. The ova have a very thin, membranous shell, measuring about 0.075 × 0.06 mm.

Subfamily *GNATHOSTOMINAE*, Baylis and Lane, 1920.

Genus *Tanqua*, R. Blanchard, 1904.

*Tanqua tiara* (v. Linst., 1879).

This common form occurred in great abundance in monitors of the following species:—

*Varanus salvator*,  
*V. flavescens*,  
*V. nebulosus*,  
*V. bengalensis*.

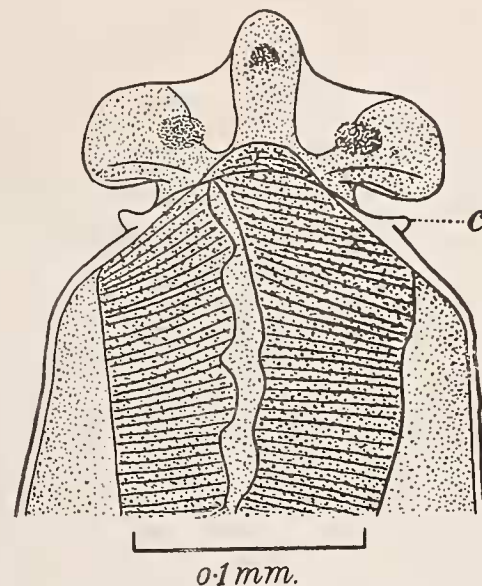


FIG. 65.—*Spiroxys annulata*. Head of female; lateral view.  
 c., cuticular collar.

**Tanqua anomala** (v. Linst., 1904).

Hosts :

“Mud snake,”

Banded krait (*Bungarus fasciatus*),

“Green snake.”

The specimens from the last-mentioned host were in bad condition, and their determination is questionable.

Genus **Echinocephalus**, Molin, 1858.

**Echinocephalus spinosissimus** (v. Linst., 1905).

A few mature, though rather small, specimens occurred in the spiral valve region of the intestine of *Trygon* (*Hypolophus*) *sephen* from the Chilka Lake on the East coast of India. The description of this species by Baylis and Lane (1920) necessarily omitted the measurements of the ova. The average size of the eggs in the present material is  $0.05 \times 0.0375$  mm. The host is a new one.

Genus **Gnathostoma**, Owen, 1836.

**Gnathostoma spinigerum**, Owen, 1836.

Specimens occurred in a fishing cat (*Felis viverrina*) and in a leopard (*Felis pardus*).

Superfamily **TRICHINELLOIDEA**, Hall, 1916.

Family **TRICHINELLIDAE**, Stiles and Crane, 1910.

Subfamily **TRICHURINAE**, Ransom, 1911.

Genus **Trichuris**, Roederer, 1761.

**Trichuris trichiura** (L., 1771).

(Syn. *Trichocephalus dispar* auctt.)

Host: Gibbon (*Hylobates*, sp.).

**Trichuris suis** (Schränk, 1788).

(Syn. *Trichocephalus crenatus* auctt.).

Host: Wild pig (*Sus bengalensis*), near Dinapore, Bihar.

**Trichuris ovis** (Abildg., 1795).

(Syn. *Trichocephalus affinis* auctt.)

Host: “Antelope”—probably the Indian antelope or black buck (*Antelope cervicapra*).

Genus **Capillaria**, Zeder, 1800.

**Capillaria columbae** (Rud., 1819).

The collection contains a few specimens of this species, which were taken from the intestine of a pigeon in company with numbers of *Ascaridia columbae*. The worm has recently been redescribed by Irwin-Smith (1920) in Australia.



Superfamily **DIOCTOPHYMOIDEA**, Railliet 1910 (*fide* Travassos, 1920 [?])

Family DIOCTOPHYMIDAE, Railliet, 1915.

Genus **Eustrongylides**, Jägerskiöld, 1909.

**Eustrongylides**, sp. (?)

Two larvae taken from a prawn at Karachi by Dr. Baini Prashad, February 11, 1915.

These two specimens, which we refer tentatively to the genus, measure respectively 12.5 mm. and 13.25 mm. in length and 0.26 mm. and 0.33 mm. in maximum thickness. The head is somewhat swollen and almost globular in shape, with a maximum diameter of 0.21–0.22 mm. The mouth is situated in a large depression, on the border of which there are six small papillae. The second ring of papillae characteristic of the adults of *Eustrongylides* has not been detected. The oesophagus is of enormous relative length, measuring 7.9 mm. and 8.25 mm. in the two specimens, or about two-thirds of the total length. It consists of a short, narrow, muscular, anterior portion, measuring 0.43–0.45 mm. from the head-end, and a very long and considerably wider, glandular, posterior portion. The tail is short (0.13–0.15 mm.) and bluntly conical, with a little cuticular button at the extremity.

The life-history of the genus *Eustrongylides* and its allies is at present obscure, but it has been suggested that certain immature forms found in fishes are the larvae of *Eustrongylides ignotus* Jägerskiöld, a species occurring in various fish-eating birds. So far as we are aware, no form found in an invertebrate has hitherto been assigned to the genus.

Superfamily **STRONGYLOIDEA**, Weinland, 1858.

Family STRONGYLIDAE, Baird, 1853, *s.s.* Lane, 1917.

Subfamily **DELETROCEPHALINAE**, Raill., 1916.

Genus **Diaphanocephalus**, Diesing, 1851.

**Diaphanocephalus willeyi** (Linst., 1904) Railliet and Henry, 1909.

(Fig. 66.)

Syn. *Kalicephalus willeyi* Linst., 1904.

Examples of this species collected from the banded krait (*Bungarus fasciatus*) form part of the collection. The species was described from *Coluber helena* and *Vipera russellii* by von Linstow (1904) and has since been reported from *Typhlops braminus* by the same author (1906 *b.*) and from *Bungarus fasciatus* (1908). We have followed Railliet and Henry (1909) in regarding the genus *Kalicephalus*, Molin, 1861, as part of the genus *Diaphanocephalus*, Diesing, 1851.

From the generic diagnosis of *Kalicephalus* given by Molin (1861) it is apparent that this genus was separated from *Diaphanocephalus* on account of (*a*) the absence of the dorsal hump just anterior to the male bursa, and (*b*) the presence of a papilliform outgrowth carrying the vulva in the female. This combination of characters is not constant, as a reference to the descriptions of *D. willeyi* and *D. minutus*

will readily show. There is no appreciable difference in the structure of the mouth-parts, upon which it is usual to base new genera in this family.

The figure of *D. willeyi* is given in order to show the rudimentary "leaf-crown," or corona radiata, surrounding the entrance to the buccal capsule. The presence of

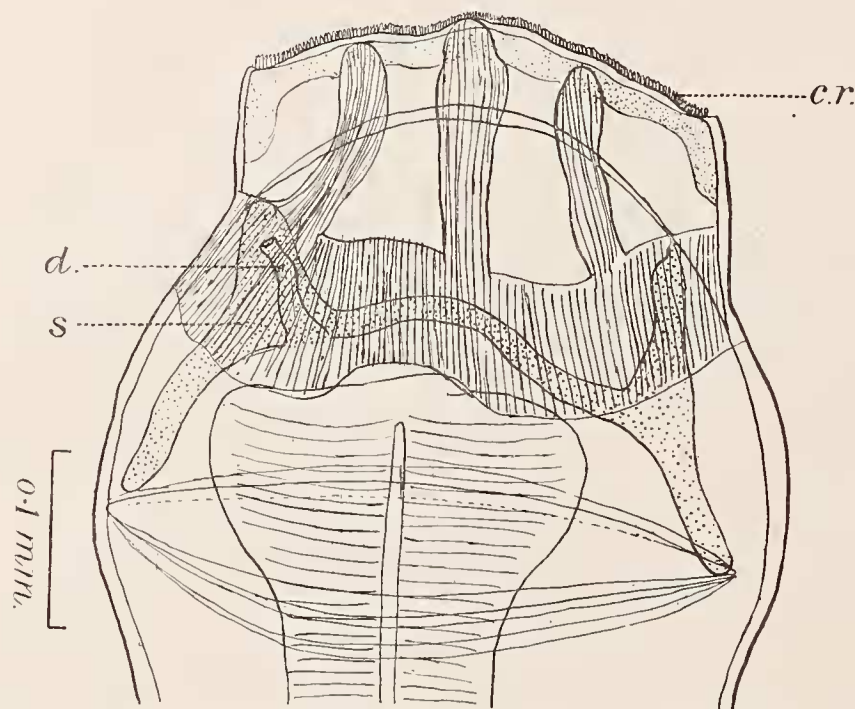


FIG. 66.—*Diaphanocephalus willeyi*. Head of female; lateral view.  
c.r., corona radiata; d., duct of dorsal oesophageal gland; s., wall of buccal capsule (optical section).

this structure in a member of the genus *Diaphanocephalus* indicates a close proximity to the members of the subfamily Strongylinæ.

The genus *Diaphanocephalus* is here referred tentatively to Railliet's subfamily Deletrocephalinae, which, if we exclude the members of Skrjabin's genus *Kiluluma*, would appear to constitute a natural group.

### *Diaphanocephalus minutus*, sp. nov.

(Figs. 67–69.)

Host: Cobra (*Naja tripudians*).

This is the smallest species so far encountered in this genus. The males measure from 4.9 to 5.0 mm. in length and 0.2 mm. in thickness; the females from 5.1 mm. to 5.3 mm. and 0.21 mm. respectively. The dorso-ventral diameter of the head is 0.15 to 0.16 mm. The head is laterally compressed. There is a distinct constriction behind it. The mouth is furnished with three pairs of small papillae which are actually the terminations of the three pairs of longitudinal parenchymatous bands characteristic of the genus. These bands are lateral and spring from a collar which surrounds the base of the buccal capsule. The collar is in the form of a horseshoe with the open ends coming practically into apposition in the dorsal middle line. The buccal capsule is about 0.2 mm. deep and is thick-walled. When viewed in optical section in the



dorso-ventral position it is roughly oblong. The central portion of the cavity extends some little way into the oesophagus. The duct of the dorsal oesophageal gland projects for more than half the length of the buccal capsule. It is supported by the wall of the capsule, which is considerably thickened (figs. 67, 68) dorsally and ventrally at its base *s*. Viewed laterally, the buccal capsule appears roughly triangular, with the apex of the triangle directed backwards. The oesophagus is short and club-shaped, measuring about 0.45 mm. in length, whilst its maximum thickness is about 0.15 mm. The nerve-ring surrounds the oesophagus at about 0.09 mm. from its anterior end. The excretory pore opens at about 0.38 mm. from the head end in the male, and 0.44 mm. in the female. The bursa of the male is completely campanulate and not easily spread out. There are three lobes, two lateral and an unpaired dorsal. The main trunk of the dorsal ray (fig. 69) is extremely large, measuring about 0.2 mm. in length, and up to 0.07 mm. in thickness just before it gives off

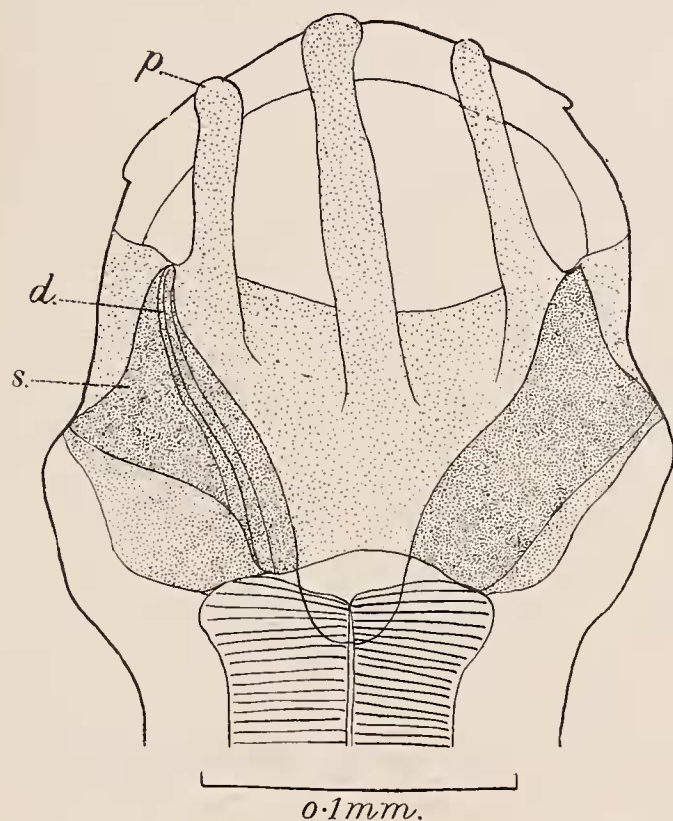


FIG. 68.—*Diaphanocephalus minutus*. Head of female; lateral view.

Lettering as in fig. 67.

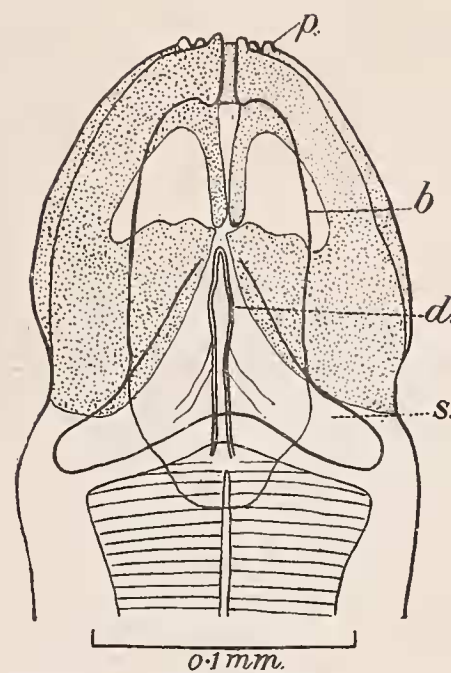


FIG. 67.—*Diaphanocephalus minutus*. Head of female; dorsal view.

*b.*, wall of buccal capsule; *d*, duct of dorsal oesophageal gland; *p.*, papilla; *s.*, wall of buccal capsule in optical section.

the large externo-dorsal rays. The latter are given off high up (about 0.16 mm. from the tip), and at a wide angle. Almost immediately behind this point the main trunk gives off a pair of stout, curved branches which together form a large horseshoe; the tips almost reaching the margin of the bursa. At its tip the dorsal ray divides into two short curved branches, the tips of which are again bifurcated. The lateral rays originate from a common root and reach almost to the edge of the bursa. The ventral rays are long and slender and closely applied to each other throughout their length. They reach the margin of the bursa. Just anterior to the origin of the bursa, there is a pair of latero-ventral papillae, which are stalked, and, though small, quite prominent.

The spicules are equal and slender and measure 0.255 to 0.275 mm. in length.



They are grooved on the ventral surface and slightly recurved at the tip. An accessory piece is absent. The anterior limit of the male genital tube is about 1.2 mm. from the head.

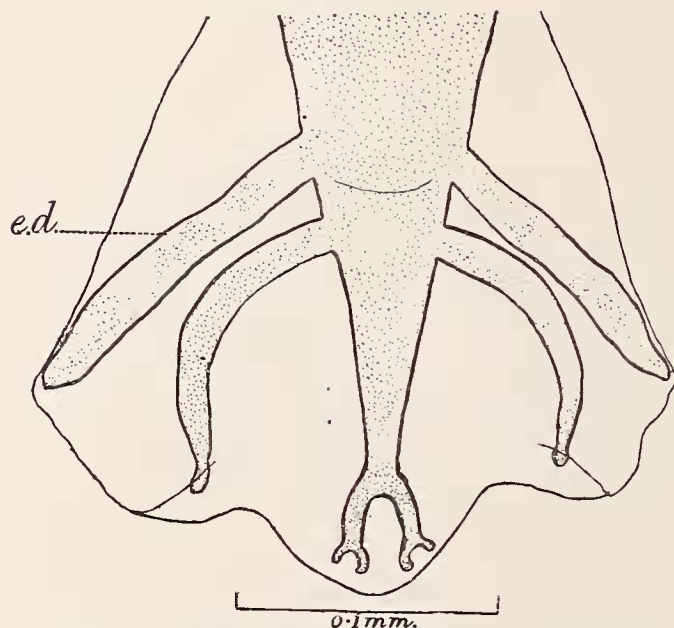


FIG. 69.—*Diaphanocephalus minutus*. Dorsal lobe of bursa; dorsal view.

e.d., externo-dorsal ray.

The tail of the female is drawn out to a rather acute point and measures 0.28 to 0.3 mm. in length. The vulva is situated in the posterior half of the body, dividing the latter in the proportion of 12.5 : 5. It is fairly prominent. There is a short vagina about 0.14 mm. long, running forwards, from which are given off two well-formed ovejectors which run anteriorly and posteriorly respectively. The combined length of the ovejectors is from 0.450 to 0.5 mm. The anterior uterus runs to within 0.8 mm. of the base of the oesophagus, whilst the posterior runs to within about 0.4 mm. from the tip of the tail. The anterior uterus is

commonly folded round the intestine, while the posterior has usually only a single bend. The ovaries commence at the points where the respective uteri bend, and run towards the middle of the body to cross each other just anteriorly to the vulva. The eggs in the uterus are thin-shelled, and measure 0.068 mm. in length by 0.031 mm. in breadth. Their contents are unsegmented.

#### *Diaphanocephalus*, sp.

One female in poor condition and a fragment of another female were collected from a cobra, *Naja tripudians*. The complete specimen is larger than the members of the preceding species, measuring 15.5 mm. in length and 0.43 mm. in thickness. The head, which is laterally compressed, measures 0.27 mm. in dorso-ventral diameter. The buccal cavity is 0.19 mm. deep. The structure of the head is similar to that described for *Diaphanocephalus minutus*. The oesophagus measures 0.485 mm. in length by 0.16 mm. in thickness. The vulva is situated in the posterior portion of the body, dividing it in the ratio of 6 : 5. Its lips are modified into a papilliform outgrowth which measures 0.141 × 0.08 mm. The ova in the uterus are thin-shelled and measure 0.065 × 0.045 mm. Their contents are unsegmented. The tail measures 0.45 mm. in length and is acutely pointed.

So far the only species described from the cobra is the preceding one, *Diaphanocephalus minutus*. The specimens under consideration differ from that species in their size and in the form of the vulvar opening.

#### *Diaphanocephalus*, sp.

Large numbers of females of a species of *Diaphanocephalus* were collected on nine different occasions from Russell's viper in Calcutta. There were no males.

The females measure from 16 mm. to 18 mm. in length and 0.46 mm. to 0.51 mm. in thickness. The head measures 0.225 mm. in dorso-ventral diameter, is laterally compressed, and is followed by a slight constriction. There are the usual three lateral pairs of parenchymatous bands, terminating anteriorly in three pairs of papillae.

The buccal cavity is similar in shape to that of *D. minutus* and is 0.21 mm. in depth. The oesophagus is *en masse* and measures 0.5 mm. in length and 0.22 mm. in maximum thickness. The nerve-ring surrounds the oesophagus at 0.35 mm. from the anterior end of the body. The excretory pore opens at 0.4 mm. from the head.

The vulva is situated in the posterior half of the body, dividing the latter in the ratio of 10.5 : 7. Its lips are modified into a papilliform process, the actual opening being on the summit of the papilla. This "papilla" is smaller than in the preceding species, measuring 0.095 × 0.085 mm. There is a short transverse vagina, at right angles to which the well-developed anterior and posterior ovejectors are given off.

The eggs in the uterus are unsegmented and measure 0.080 × 0.048 mm. The anus is situated at 0.72–0.75 mm. from the tip of the tail, which is drawn out to an acute point.

Discovery of the males may prove that this species and the foregoing are identical. The differences observed in the single specimen from the cobra are too slight to warrant definite separation.

#### Family ANCYLOSTOMIDAE, Looss, 1911.

Subfamily *ANCYLOSTOMINAE*, Looss, 1905, *emend.* Lane, 1917.

Genus *Ancylostoma* (Dubini, 1843) Creplin, 1845.

The collection contains all the species of this genus known to occur in India. These are fairly well-known, and we propose only to give lists of the hosts from which they were collected, with brief comments where necessary.

#### *Ancylostoma duodenale* (Dubini, 1843).

Hosts:

Tiger (*Felis tigris*).

Fishing cat (*Felis viverrina*).

Lane (1917 *b*) has given an account of the occurrence of this species in the tiger. He observed that the specimens, though mature, were somewhat stunted in size, which may be an indication that the worm, now occurring mainly as a human parasite, finds the conditions of living in the tiger adverse to the attainment of its full size. The same failure to reach the normal size is observable in the material in the present collection. From the tiger there are several specimens of both sexes; from the fishing cat only a single female. The fact that this species can live in wild Felidae indicates that it may eventually be discovered in the domestic cat (*cf. A. caninum* and *A. ceylanicum*).

**Ancylostoma caninum** (Ercolani, 1859).

## Hosts :

Wild dog (*Cyon dukhunensis*).  
Indian wolf (*Canis pallipes*).  
Indian jackal (*Canis aureus*).  
Indian fox (*Vulpes bengalensis*).  
Indian desert fox (*Vulpes leucopus*).  
Sloth-bear (*Melursus ursinus*).  
Tiger (*Felis tigris*).  
Leopard (*Felis pardus*).  
Fishing cat (*Felis viverrina*).  
Domestic cat.

**Ancylostoma ceylanicum**, Looss, 1911.

## Hosts :

Civet (probably *Viverricula malaccensis*).  
Tiger (*Felis tigris*).  
Lion (*Felis leo*).  
Leopard (*Felis pardus*).  
Fishing cat (*Felis viverrina*).  
Leopard cat (*Felis bengalensis*).  
Domestic cat.  
Wild dog (*Cyon dukhunensis*).  
Indian wolf (*Canis pallipes*).  
Sloth-bear (*Melursus ursinus*).  
Red cat-bear (*Aelurus fulgens*).

**Ancylostoma malayanum**, Alessandrini, 1905.

## Hosts :

Malay bear (*Ursus malayanus*).  
"Bear"—probably the Sloth-bear (*Melursus ursinus*).

Genus **Galoncus**, Railliet, 1918.**Galoncus perniciosus** (v. Linstow, 1885) Railliet, 1918.

The collection contains one female only of this species, collected from the intestine of a leopard (*Felis pardus*) in the Zoological Gardens, Calcutta.

We have nothing to add to the description given by Railliet beyond remarking that the head is evidently retractile, and in the extended state the buccal capsule appears relatively much larger in proportion to the width of the body of the worm. The specimen figured by Railliet (1918) is in the retracted state. Doubtless the powerful muscles attached to the lateral walls of the buccal capsule, which were noticed by Railliet and other authors, are connected with the retraction of the head.



This genus appears to form a link between the subfamilies Ancylostominae and Necatorinae.

Subfamily *NECATORINAE*, Lane, 1917.

Genus *Necator*, Stiles, 1903.

*Necator americanus* (Stiles, 1902).

We have to record the occurrence of this species in a new host, *viz.* a young African rhinoceros\* (*R. bicornis*), which had lived in the Zoological Gardens, Calcutta for a very short time. The animal was captured in the Tanganyika Territory (formerly German East Africa) and was brought to India by Mr. E. W. Harper, to whom we are indebted for this information.

Careful comparison of this material with specimens of *Necator americanus* from man in the collection of the British Museum reveals no difference except that the female specimens from the rhinoceros are slightly the longer. They measure from 11 to 13 mm. in length and 0.4 mm. in thickness, as against 10 to 12 mm. and 0.4 mm. respectively in the case of the specimens from man.

The subfamily Necatorinae was proposed by Lane (1917 *a*) to replace the older subfamily Bunostominae, Looss, 1911. The difference between these two groupings is that, according to Lane, the genus *Uncinaria* approaches more nearly to the *Necator* and *Bunostomum* group than to the Ancylostominae, among which it was placed by Looss. It is interesting to recall that of the subfamily Necatorinae, if *Uncinaria* be left out of account, all the members except *Necator* occur in herbivorous animals only,<sup>1</sup> and, in consequence, the occurrence of *Necator* in the rhinoceros is not so astonishing as it might appear at first sight. All the species of *Ancylostoma* occur in carnivores, and all except *Ancylostoma duodenale* and *A. ceylanicum* in carnivores only. It seems probable, therefore, that the original hosts of the species now found in man were carnivores. It is also almost certain that *Necator americanus* was introduced into America with the African slaves, and if this is the case, man may have acquired his earliest infestations with this parasite from some wild herbivore inhabiting Africa.

Family TRICHOSTRONGYLIDAE, Leiper, 1912.

Subfamily TRICHOSTRONGYLINAE, Leiper, 1908.

Genus *Haemonchus*, Cobb, 1898.

*Haemonchus contortus* (Rud., 1803).

This species occurred in the Markhor (*Capra falconeri*) in the Zoological Gardens, Calcutta.

*Haemonchus cervinus*, sp. nov.

The collection includes several females of a species of *Haemonchus* from a spotted deer (*Cervus axis*). The specimens are in poor condition. They measure from 13 to

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<sup>1</sup> Since the preparation of this paper, *Necator* has been recorded from the pig in Trinidad (Ackert and Payne, *Amer. Jl. of Hyg.*, II, 1, Jan., 1922). The authors regard the form found in pigs as a new species, which they have named *N. suillus*.

15 mm. in length and up to 0.4 mm. in thickness. The body tapers uniformly anteriorly to a small head which measures 0.023 to 0.025 mm. in diameter. The mouth contains the single small lancet characteristic of the genus. The cervical spines are situated at about 0.37 mm. from the anterior end. The oesophagus is slender, and measures about 1.2 mm. in length. It is encircled by the nerve-ring at about 0.25 mm. from the anterior end. The excretory pore is just behind the level of the nerve-ring.

The vulva is slightly prominent, but possesses no overhanging anterior lip such as is found in *H. contortus*. It is situated at about 11 mm. from the anterior end. There is a short, transverse vagina, from which well-developed anterior and posterior ovejectors are given off. The eggs in the uterus measure 0.08–0.09 mm.  $\times$  0.04–0.05 mm., and their contents are unsegmented. The tail is long and slender. The anus is situated at about 0.37 mm. from the tip.

In addition to the females this batch of specimens includes one male. The bursa of this specimen is incomplete, and the whole worm so badly damaged that we have found it impracticable to give a description of the male.

Family METASTRONGYLIDAE, Leiper, 1908.

Subfamily RICTULARIINAE, Hall, 1913.

Genus *Rictularia*, Fröl., 1802.

*Rictularia*, sp.

A single female specimen, taken from the intestine of a palm-civet (*Paradoxurus hermaphroditus bondar*,<sup>1</sup> though labelled "*Paradoxurus niger*"), caught in the Museum compound, Calcutta.

*Rictularia plagiostoma* (Wedl) has been recorded as a parasite of a palm-civet by Leiper.<sup>2</sup> The present specimen, however, does not agree with the careful description of *R. plagiostoma* given by Jägerskiöld (1909), and we refrain from attempting to attach a specific name to it.

*Fam. incert.*

Genus *Scolecophilus*, nov.

*Scolecophilus lumbricicola*, sp. nov.

(Figs. 70, 71.)

Host: an earthworm (*Perionyx m'intoshi*, Beddard). Locality: Nepal Valley.

This nematode was found by Dr. J. Stephenson in the body-cavity of the host, in the tenth and eleventh segments. He noted that in the former segment they were surrounded by masses of what appeared to be the spermatozoa of the host. The material is not in a perfect state of preservation, having, no doubt, been removed from the host after death. We are unable, therefore, to give a very complete account of the anatomy. The species, however, shows certain remarkable features which make it worthy of a brief description.

<sup>1</sup> See Robinson and Kloss, *Rec. Ind. Mus.*, XIX, Part IV, 1920, p. 178.

<sup>2</sup> *Proc. Zool. Soc. London*, 1911, p. 620.

The male measures 3.65–4.15 mm. in length and 0.4–0.5 mm. in thickness; the female 6.0–6.5 mm. and 0.5–0.6 mm. respectively. In general shape (fig. 70) the worms are rather short and stout. The male has its blunt tail strongly curled ventrally, while the posterior end of the female is straight and conical. The anterior end tapers more gradually than the posterior. The cuticle is thin and smooth, except in the region of the lateral fields. These are very conspicuous, being very broad and of a granular appearance, and the cuticle covering them, especially near the anterior and posterior ends, is thrown into strongly-marked transverse furrows. The width of the lateral fields is about 0.1 mm. anteriorly, increasing posteriorly to about 0.22 mm. Near the tail they bend round towards the ventral surface. The musculature is apparently of the meromyarian type. The head is somewhat abruptly truncate. The mouth shows no recognizable lips or papillae. The oesophagus is slender, passing posteriorly into a relatively large, glandular bulb of almost oblong shape. The entire oesophagus, including the bulb, is 0.7–0.76 mm. long in the male, 0.8–0.9 mm. in the female. The bulb measures about 0.35 mm. in length and 0.17 mm. in diameter. It is connected with the intestine by a narrow neck containing some kind of valvular apparatus. The intestine is apparently modified into a “fat-body” somewhat resembling that of the Mermithidae. An anal aperture appears to be absent, the intestine terminating blindly behind. The nerve-ring is situated at about 0.13 mm. from the anterior end. No excretory pore has been seen.

In the male, there are paired spicules and an accessory piece. The shape of the spicules is highly characteristic, and is more readily conveyed by a figure (fig. 71) than by description. Each spicule is broad at the base, and bent at right angles at about its middle. In the males examined, the spicules were protruded as far as the bend, and had their tips directed laterally, as shown in the figure. The tip of each spicule is bifurcated, ending in two sharp points of slightly unequal length, separated by a deep cleft. The spicules measure 0.18 mm. in length (following the bend). The dorsal portion of the accessory piece is roughly triangular, broader behind than in front, and appears to send down lateral processes at the sides of the spicules. No caudal papillae have been made out.

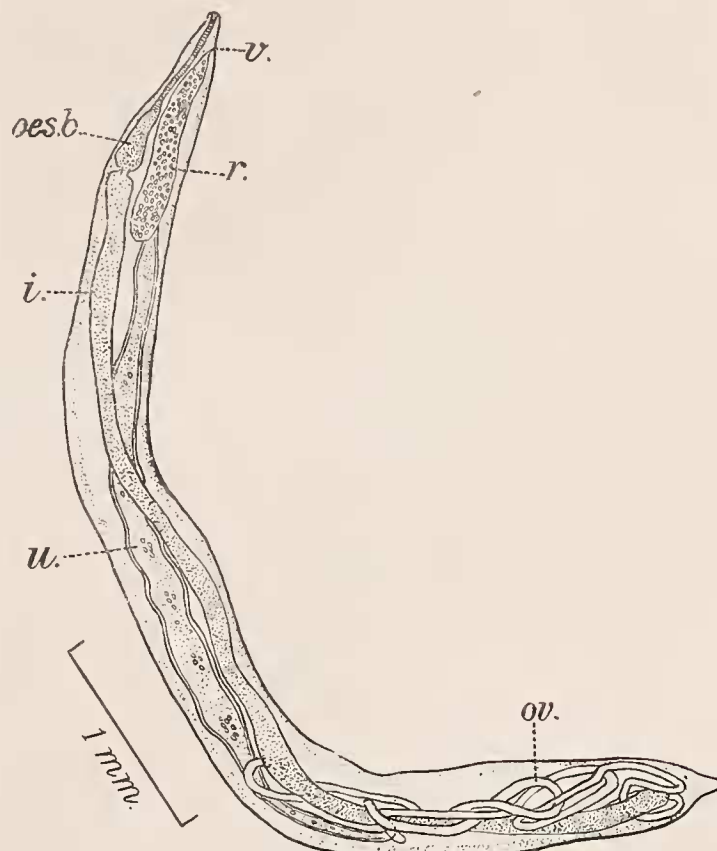


FIG. 70.—*Scolecophilus lumbricicola*. Female; lateral view.

*i.*, intestine; *oes.b.*, oesophageal bulb; *ov.*, ovary; *r.*, rudiment of second uterus; *u.*, functional uterus; *v.*, vulva.



In the female, the vulva is situated at about 0.18 mm. from the anterior end. Its position is usually marked by a sudden change in the diameter of the worm, the portion anterior to it being much narrower than the rest of the body. The general arrangement of the female organs is shown in fig. 70. There is no ovejector or muscular vagina. Only one genital tube is complete and functional. The uterus runs back almost straight for some three-quarters of the length of the body, and shows little accumulations of imperfectly-formed ova here and there along its course.

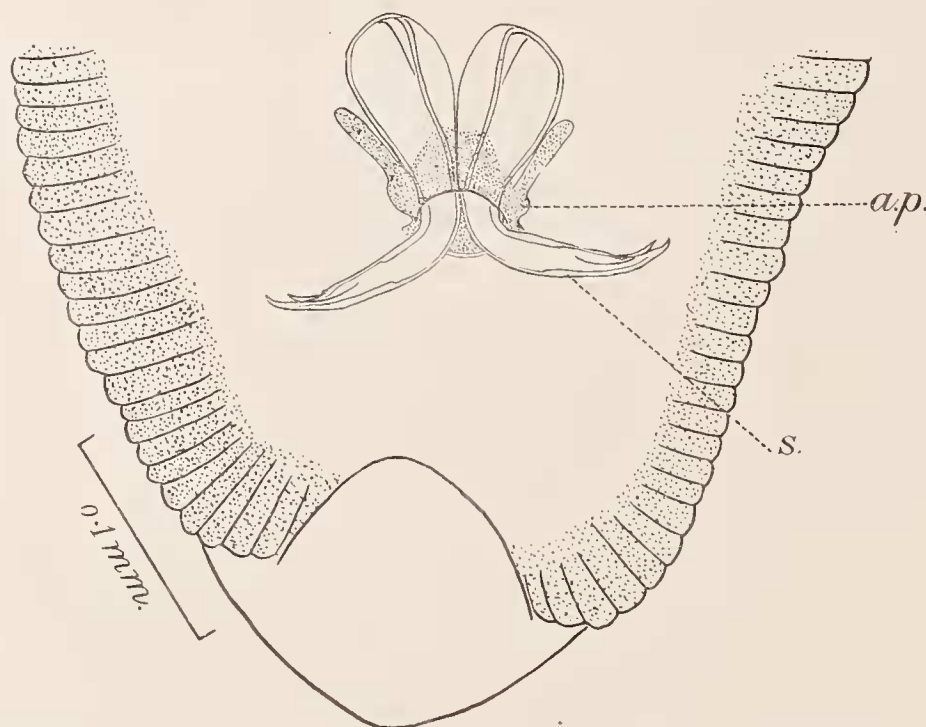


FIG. 71.—*Scolocophilus lumbricicola*. Tail of male; ventral view.  
a.p., accessory piece; s., left spicule.

The coils of the oviduct and ovary are confined to about the posterior third of the body. The other uterus appears to be represented by a blind sac, lying alongside of the anterior portion of the functional uterus, and serving as a reservoir in which the fully-formed ova are stored before being laid. This sac may run back, in large specimens, to a point about 2.5 mm. from the anterior end, and is generally crowded with eggs. These are of oval shape, with a thin shell, measuring about  $0.065 \times 0.038$  mm., and containing a crescentic embryo.

The absence of one branch of the uterus is not uncommon among nematodes, and is most frequently seen in cases where the vulva has been displaced far from its "primitive" median position towards either of the extremities of the worm. This modification is met with among certain free-living forms, as well as in several families, or isolated genera and species, of nematodes parasitic in vertebrates. But there is one group of forms (all of which are, at least during a certain phase of their existence, parasitic in invertebrates), to which the present form is perhaps most closely related. This is the group including *Allantonema*, *Atractonema*, *Bradynema* and *Sphaerularia*. These forms are generally placed among the Mermithidae, though it seems doubtful whether such a classification would bear critical examination. They do, at all events, share with *Mermis* and its close allies, with the present species, and with one or two other isolated genera (*Aprocta*, *Aproctonema*), the peculiarity of having no posterior opening to the intestine in the adult form. The alimentary canal is, moreover, in these forms, either

entirely absent in the adult female, or reduced, as in the Mermithidae, to a more or less solid organ functioning as a reserve of food-material. Again, in all these forms the female genital apparatus is reduced to a single uterus and ovary. The vulva, however, is not anteriorly but posteriorly situated. The worms are either protandrous hermaphrodites, or the sexes are separate, only the females and young larvae being parasitic. A position in some respects intermediate between the present form and the group referred to might perhaps be assigned to the genus *Aproctonema*, Keilin, 1917. This is represented by *A. entomophagum*, Keilin, of which the separate sexes are both parasitic in the larvae of a Dipterous insect. The oesophagus of *Aproctonema* has a somewhat similar structure to that of *Scolecophilus*. The intestine (which has an anterior diverticulum), is a solid "fat-body", and has no posterior opening. There are two opposed uteri in the female, and the vulva is situated somewhat behind the middle of the body.

A sac-like vestige of the second uterus, somewhat like that described above for *Scolecophilus*, has been observed in *Sphaerularia*, and also in some of the free-living "monodelphic" forms. It appears in some cases to act as a receptaculum seminis rather than a reservoir for developing eggs, but possibly it serves both purposes.

#### FORMS OF FREE-LIVING (ANGUILLULID) TYPE.

Genus **Cephalobus**, Bastian, 1865.

**Cephalobus seistanensis**, sp. nov.

(Figs. 72, 73.)

A number of minute nematodes were collected by Dr. N. Annandale and Dr. S. W. Kemp from the tissues of the water-snail, *Gyraulus convexiusculus*, in reed-beds in the Hamun-i-Helmand, Seistan, E. Persia. These specimens may have been in the pulmonary cavity. They had a reddish colour when alive, like that of the blood of the mollusc. They probably belong to the genus *Cephalobus*, of which one member, *C. bütschlii* de Man, is known to be, at least at times, a parasite of certain fresh-water snails (*Succinea*), though most of the species are free-living or to some extent parasites of plants.

The present species has a length of 0.95–1.08 mm. in the male and 1.3–1.43 mm. in the female. The maximum thickness of the male is about 0.025 mm., of the female 0.035 mm. The oesophagus is from 0.2 to 0.27 mm. long, and is composed of a long anterior muscular portion, narrow anteriorly and posteriorly, but somewhat swollen for about the middle third, and a rather elongated, fusiform, posterior glandular portion, or bulb, of larger diameter. This bulb is not distinctly marked off from the rest of the oesophagus. The nerve-ring surrounds the muscular portion at the back of its swollen middle region.

The caudal end of the male is strongly coiled ventrally. The tail is 0.05 mm. in length and tapers sharply to a fine point. There are two equal, broad spicules, 0.026 mm. long,

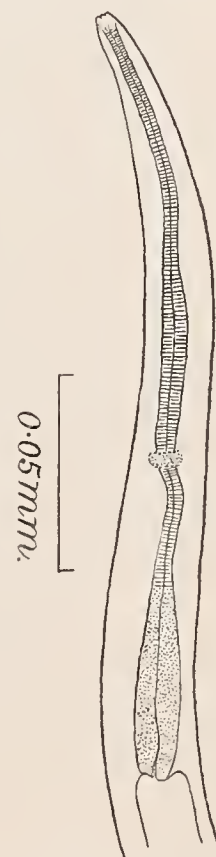


FIG. 72.—*Cephalobus seistanensis*. Anterior end.



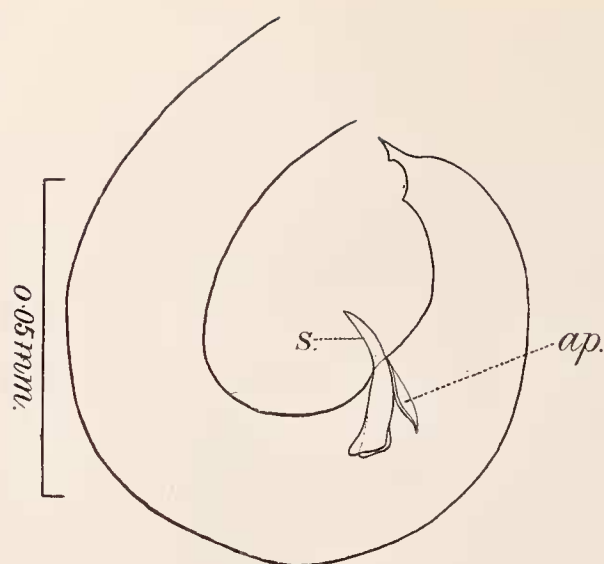


FIG. 73.—*Cephalobus seistanensis*. Posterior end of male; lateral view.

*a.p.*, accessory piece; *s.*, right spicule.

and an accessory piece 0.015 mm. long. The only caudal papillae appear to be two small ventral pairs near the extremity of the tail.

The tail of the female is tapering, 0.08 mm. long, and curves towards the dorsal side. The vulva opens at about 0.55 mm. from the posterior end, *i.e.* somewhat behind the middle of the body. The single genital tube runs forward for about 0.3 mm., and then doubles upon itself to run straight backward, the blind end of the ovary being situated at about 0.1–0.15 mm. behind the vulva. The uterus, in mature females, never seems to contain more than one fully-

formed ovum at a time. Such ova have an unsegmented content and measure 0.045 × 0.025 mm.

The relative dimensions of this species, expressed according to the formula of de Man, would be somewhat as follows:  $\alpha = 38-40.85$ ;  $\beta = 4.75-5.3$ ;  $\gamma = 19$  in male, 17.8 in female.

#### Genus *Monhysterides*, nov.

#### *Monhysterides piscicola*, sp. nov.

(Figs. 74, 75.)

Host: Mahseer (*Barbus tor*). Locality: Torsa River, Falakata, Eastern Bengal.

This is a very small form, the male measuring 3.5–4.0 mm. in length, the female 3.7–4.4 mm. The maximum thickness is 0.15–0.2 mm. The body is slender and tapering towards each extremity, the middle region being relatively stout. The diameter of the head is 0.03–0.04 mm. The cuticular striation is exceedingly fine. Owing to the very small size of the head the characters of the mouth are difficult to determine. It appears to be surrounded by six small nodules, two of which are probably lateral, two subdorsal and two subventral. There are indications of minute papillae near their bases. The oesophagus consists of a short anterior portion which is transparent and purely muscular, about 0.2 mm. long, and a longer posterior portion which is partly glandular and partly muscular, and is swollen behind. This portion may

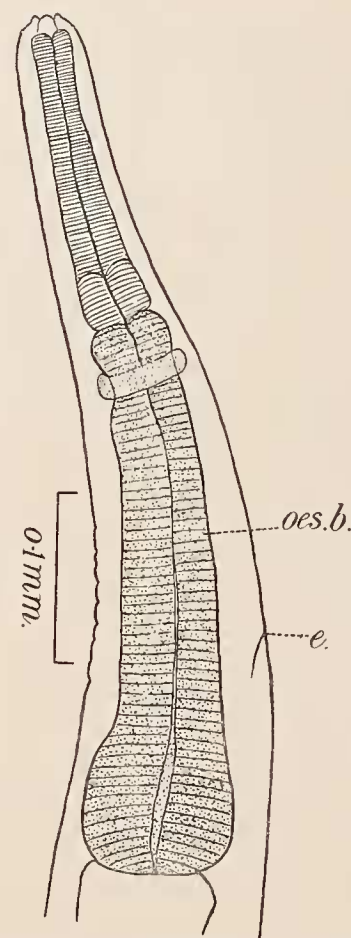


FIG. 74.—*Monhysterides piscicola*. Anterior end of female; lateral view.

*e.*, excretory pore; *oes.b.* oesophageal bulb.



probably be regarded as a pear-shaped bulb of an unusually elongate shape. It measures about 0.32 mm. in length and 0.065–0.09 mm. in thickness posteriorly. The anterior, muscular portion of the oesophagus appears to be divided transversely near its posterior end, by a kind of diaphragm, into two parts of slightly different histological appearance. The nerve-ring surrounds the neck of the “bulb” (not the muscular part of the oesophagus, as is usually the case), near its origin, *i.e.* at about 0.22 mm. from the head-end of the worm. The excretory pore is situated at about 0.4 mm. from the anterior end.

In the male, the tail measures 0.34 mm. in length, and tapers to a very fine point. There are two very unequal tubular spicules, of which the left measures 0.21 mm. in length, the right 0.08 mm. The tip of the long spicule is bluntly rounded, that of the short spicule more pointed. There is no accessory piece. There are nine pairs of caudal papillae, of which four are preanal and five postanal. The preanal papillae are all very close together, near the cloaca, and these and the most anterior pair of postanal papillae are very large and prominent, projecting ventrally. Of the remaining postanal pairs, which are smaller, one is laterally situated, not far from the cloaca, and the rest form a triangle, two being ventral and one lateral, at about the middle of the tail.

The female has a finely tapering tail, 0.55–0.65 mm. long. The vulva is situated at about 0.45 mm. in front of the anus, and the uterus and ovary are single. The latter is situated anteriorly, and is reflexed at about 1.2 mm. from the anterior end. The worm is viviparous, the embryos being at first enclosed in large, oval, membranous shells, measuring 0.275 × 0.125 mm., but subsequently hatching *in utero*. The voluminous uterus may contain at one time some 15 to 20 eggs containing embryos in various stages of development, and about four or five free embryos. The latter are about 1 mm. long, or roughly a quarter of the length of the parent.

The systematic position of this species is somewhat doubtful, but we are inclined to regard it as a member of the usually free-living family Anguillulidae that has recently taken to a parasitic mode of life. It does not show the specialization of the female genital apparatus which usually takes place in true internal parasites. One of us (Baylis (1915)) has described two semi-parasitic species apparently belonging to the genus *Monhystera*, and it is to this genus that the present form seems to approach most closely in its general anatomy.

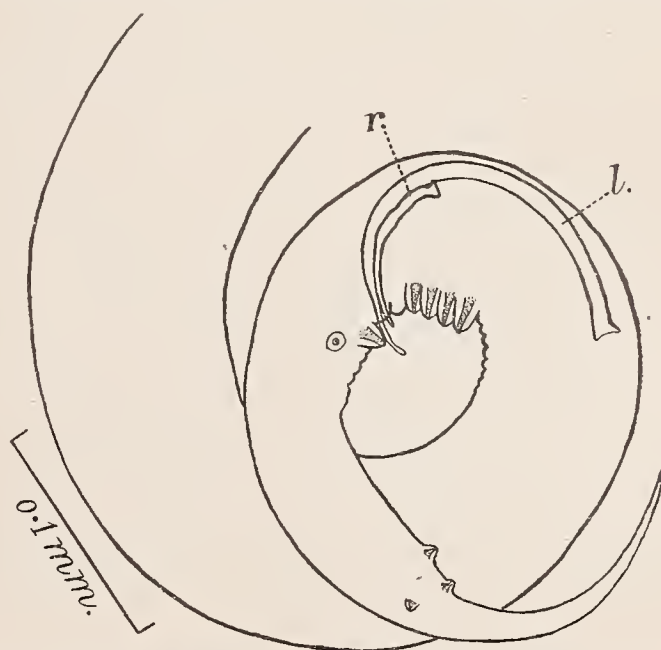


FIG. 75.—*Monhysterides piscicola*. Posterior end of male; lateral view.

*l.*, left spicule; *r.*, right spicule.

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